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Department of Biodiversity,
Conservation and Attractions

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VOLUME 33 2022

DEPARTMENT OF BIODIVERSITY, CONSERVATION AND ATTRACTIONS
WESTERN AUSTRALIA

Nuytsia

Nuytsia is an open access, peer-reviewed journal that publishes original research on the systematics, taxonomy and nomenclature of Australian (particularly Western Australian) plants, algae and fungi.

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Department of **Biodiversity,
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CONTENTS

| | |
|--|-----|
| Updates to Western Australia's vascular plant census for 2021. C.M. Parker and J.M. Percy-Bower | 1 |
| <i>Stylidium milleri</i> (Stylidiaceae), a striking discovery from south-western Australia. J.A. Wege | 15 |
| <i>Drummondita billyacatting</i> (Rutaceae), a new, range-restricted species from Western Australia. L.R.J. Shelton and K.R. Thiele..... | 19 |
| The Button Mangrove <i>Conocarpus erectus</i> (Combretaceae) is naturalised in Western Australia. G.J. Keighery and V. Long..... | 29 |
| The correct name for the weedy <i>Homalanthus</i> (Euphorbiaceae) in Western Australia. G.J. Keighery and A.A. Mitchell | 35 |
| <i>Austrostipa</i> (Poaceae) in Western Australia: new species, new records, keys, and character notes. A.R. Williams..... | 39 |
| <i>Exocarpos capnodioides</i> (Santalaceae), a new species from southern Australia allied to <i>E. aphyllus</i> . B.J. Lepschi..... | 103 |
| From Engler to APGIV: a short history of the botanical arrangement of the Western Australian Herbarium collections. C.M. Parker, J.M. Percy-Bower and S.A. James..... | 113 |
| The status of <i>Albizia lebbbeck</i> (Fabaceae: Mimosoideae) in Western Australia. G.J. Keighery | 143 |
| Reassessment of the type collections of W. Fitzgerald's <i>Calandrinia tepperiana</i> (Montiaceae) leads to the discovery of a putative new species from the Kimberley. F.J. Obbens..... | 147 |
| An expanded circumscription and revision of the Western Australian genus <i>Balaustion</i> (Myrtaceae: Chamelaucieae: Hysterobaeckeinae). B.L. Rye..... | 149 |
| <i>Conostephium wonganense</i> , <i>Dielsiodoxa altimontana</i> and <i>Styphelia blackallii</i> – three rare, new epacrids (Ericaceae: Epacridoideae) from Western Australia. M. Hislop | 205 |
| <i>Eriochilus glareosus</i> (Orchidaceae), a new species from south-west Western Australia. G. Brockman1 and C.J. French | 217 |
| Three new Western Australian species related to <i>Calytrix violacea</i> (Myrtaceae: Chamelaucieae). K.R. Thiele, G.J. Keighery, F.J. Nge and B.L. Rye..... | 221 |
| Description of a new south-western Australian plant group, <i>Hypocalymma</i> sect. <i>Grandiflora</i> (Myrtaceae: Chamelaucieae: Astarteinae). B.L. Rye, G.J. Keighery and M.D. Barrett | 233 |

Calytrix calingiri, a new species from the *Calytrix acutifolia* species group
(Myrtaceae: Chamelaucieae). F.J. Nge and K.R. Thiele..... 251

A new species of *Brachyachne* (Poaceae: Chloridoideae: Cynodonteae) from semi-
arid Northern Territory and Western Australia, and additional notes on the genus..
D.E. Albrecht and T.G.B. McLay 263

A taxonomic review of the *Styphelia tamminensis* subgroup (Ericaceae:
Epacridoideae: Styphelieae). M. Hislop and H.K. Nguyen 275

Reduction of *Corynanthera* to the synonymy of *Micromyrtus* (Myrtaceae:
Chamelaucieae: Micromyrtinae). B.L. Rye and P.G. Wilson..... 321

Synonymisation of taxa, correction of a misapplied name and an updated key for the
Western Australian *Leptospermum erubescens* species group (Myrtaceae:
Leptospermeae). R.M. Binks, M. Hislop and M. Byrne..... 325

Other content

Referees for Volume 33..... 331

Updates to Western Australia's vascular plant census for 2021

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SHORT COMMUNICATION

The census database at the Western Australian Herbarium (PERTH), which provides the nomenclature for the website *Florabase* (Western Australian Herbarium 1998–), lists current names and recent synonymy for Western Australia's native and naturalised vascular plants, as well as algae, bryophytes, lichens, slime moulds and some fungi. The names represented in the census are either sourced from published research or denote as yet unpublished names based on herbarium voucher specimens. We herein summarise the changes made to vascular plant names in this database during 2021.

Sixty three taxa were newly recorded for the State, of which seven are naturalised and 18 have been added to the Threatened and Priority Flora list for Western Australia (Smith & Jones 2018; Western Australian Herbarium 1998–) (Table 1). A total of 153 name changes were made, including the formal publication of 20 phrase-named taxa (Table 2). Plant groups for which several name changes were made include *Baumea* Gaudich. (Wilson 2015) and *Corynotheca* Benth. (Barrett *et al.* 2021c). Ongoing research resulted in numerous publications supporting four new species and five new combinations in *Nicotiana* L. (Chase & Christenhusz 2021a; Chase & Christenhusz 2021b; Chase & Christenhusz 2021c; Chase & Christenhusz 2021d; Chase *et al.* 2021a; Chase *et al.* 2021b; Chase *et al.* 2021c; Chase *et al.* 2021d). New genera to Western Australia in 2021 included *Apatelantha* T.C.Wilson & Henwood (Wilson *et al.* 2021), *Netrostylis* R.L.Barrett, J.J.Bruhl & K.L.Wilson removed from *Tetraria* P.Beauv. (Barrett *et al.* 2021a) and *Ammothryon* R.L.Barrett, K.L.Wilson & J.J.Bruhl (Barrett *et al.* 2021b). An older genus *Grona* Lour. was separated and reinstated from *Desmodium* Desv. (Ohashi & Ohashi 2018). Table 2 also includes cases where there has been a change of taxonomic concept, misapplication, exclusion or rank change.

Table 1. New records added to Western Australia's vascular plant census during 2021. *in litt.* = in correspondence; *in sched.* = on herbarium sheet/label; * = naturalised; T, P1–P4 = Department of Biodiversity, Conservation and Attractions Conservation Codes for Western Australian flora (Smith & Jones 2018; Western Australian Herbarium 1998–).

| New Name | Status | Comments |
|---|--------|---|
| <i>Anarthria dioica</i> (Steud.) C.I.Fomichev | | See Fomichev <i>et al.</i> (2021). |
| <i>Anarthria grandiflora</i> Nees | | New record for WA. See Fomichev <i>et al.</i> (2021). |

| New Name | Status | Comments |
|--|--------|--|
| <i>Anthocercis anisantha</i> subsp. <i>collina</i> Haegi | | New record for WA. L. Haegi <i>in litt.</i> (07/09/2021). |
| <i>Arisarum vulgare</i> O.Targ.Tozz. | * | New naturalised record for WA. M. Hislop <i>in sched.</i> (30/11/2020). |
| <i>Caladenia</i> sp. Bulbarnet (G. Brockman GBB 2880) | | A.P. Brown <i>in litt.</i> (13/11/2020). |
| <i>Calandrinia</i> sp. Berry Springs (M.O. Parker 855) | | F. Obbens <i>in sched.</i> (23/08/2021). |
| <i>Calandrinia</i> sp. Hamelin Station (F. Obbens FO 02/20) | P1 | F. Obbens <i>in litt.</i> (25/03/2021). |
| <i>Calytrix</i> sp. Cape Riche (G.J. Keighery & B.J. Keighery 2934) | P1 | F. Nge <i>in litt.</i> (19/01/2021). |
| <i>Calytrix</i> sp. Wandana (G. Byrne 1750) | P3 | B.L. Rye <i>in litt.</i> (04/05/2021). |
| <i>Conocarpus erectus</i> L. | * | New naturalised record for WA. G.J. Keighery <i>in litt.</i> (28/07/2021). |
| <i>Corynotheca borealis</i> R.L.Barrett, Keighery & T.Macfarlane | | See Barrett <i>et al.</i> (2021c). |
| <i>Corynotheca dichotoma</i> (F.Muell.) Benth. | | New record for WA. See Barrett <i>et al.</i> (2021c). |
| <i>Corynotheca licrota</i> R.J.F.Hend. | | New record for WA. See Barrett <i>et al.</i> (2021c). |
| <i>Drosera margaritacea</i> T.Krueger & A.Fleischm. | | See Krueger <i>et al.</i> (2021). |
| <i>Drosera</i> sp. Kentdale (G.J. Bourke 458) | | T. Krueger <i>in litt.</i> (20/09/2021). |
| <i>Drosera</i> sp. Lesueur National Park (C.A. Gardner 9350) | | T. Krueger <i>in litt.</i> (20/09/2021). |
| <i>Eulalia simonii</i> R.M.Butler & Trudgen | | See Butler & Trudgen (2021). |
| <i>Euphorbia papillata</i> Halford & W.K.Harris | | New record for WA. M. Hislop <i>in sched.</i> (30/11/2021). |
| <i>Euphorbia papillata</i> Halford & W.K.Harris var. <i>papillata</i> | | New record for WA. M. Hislop <i>in sched.</i> (30/11/2021). |
| <i>Ficus desertorum</i> B.C.Wilde & R.L.Barrett | | See Wilde & Barrett (2021). |
| <i>Fitzwillia</i> sp. Newdegate (A. Coates 8766) | P1 | M. Hislop <i>in litt.</i> (14/01/2021). |
| <i>Glinus oppositifolius</i> var. <i>keenanii</i> (C.B.Clarke) Sukhor. | | See Sukhorukov <i>et al.</i> (2021). |
| <i>Gonocarpus keigheryi</i> M.L.Moody | | See Moody & Garcia (2021). |
| <i>Gonocarpus orchardii</i> M.L.Moody | | See Moody & Garcia (2021). |
| <i>Goodenia</i> sp. Charnley River (M.D. Barrett MDB 5163) | P1 | M.D. Barrett <i>in litt.</i> (10/12/2020). |
| <i>Grevillea brachystylis</i> subsp. Yelverton (A. Webb AW09122) | P2 | A. Webb <i>in litt.</i> (17/03/2021). |
| <i>Grevillea merceri</i> Olde & Marriott | | See Olde & Marriott (2021). |

| New Name | Status | Comments |
|--|--------|--|
| <i>Grevillea trichantha</i> Olde | | See Olde (2021b). |
| <i>Hibiscus</i> sp. Kununurra (K.F. Kenneally 1940) | | A. Markey <i>et al. in sched.</i> (21/09/2021). |
| <i>Hypocalymma suave</i> Lindl. | | New record for WA. B.L. Rye <i>in litt.</i> (04/05/2021). |
| <i>Indigofera deserticola</i> Peter G. Wilson & Rowe | | See Wilson (2021). |
| <i>Indigofera rotula</i> Peter G. Wilson | | See Wilson (2021). |
| <i>Kunzea petrophila</i> Toelken | P1 | New record for WA. R.L. Barrett <i>in litt.</i> (17/12/2020). |
| <i>Lolium arundinaceum</i> (Schreb.) Darbysh. subsp. <i>arundinaceum</i> | * | New naturalised record for WA. See Banfi <i>et al.</i> (2017). |
| <i>Lycopus europaeus</i> L. | * | New naturalised record for WA. See Keighery (2021). |
| <i>Microcorys</i> sp. Parker Range (C. Hancock s.n. PERTH 09215123) | P2 | M. Hislop <i>in litt.</i> (12/01/2021). |
| <i>Nicotiana insecticida</i> M.W.Chase & Christenh. | | See Chase & Christenhusz (2021b). |
| <i>Nicotiana murchisonica</i> M.W.Chase & Christenh. | | See Chase <i>et al.</i> (2021d). |
| <i>Nicotiana pila</i> M.W.Chase & Christenh. | | See Chase & Christenhusz (2021c). |
| <i>Nicotiana salina</i> M.W.Chase, M.F.Fay & Christenh. | | See Chase <i>et al.</i> (2021c). |
| <i>Olearia</i> sp. Jerramungup (E.M. Sandiford 2528) | P1 | M. Hislop <i>in litt.</i> (21/04/2021). |
| <i>Opuntia leoglossa</i> Font & M.Köhler | * | See Köhler & Font (2021). |
| <i>Pandorea jasminoides</i> (G.Don) K.Schum. | * | New naturalised record for WA. See Keighery & Keighery (2021). |
| <i>Paranotis</i> sp. Pilbara (H. Ajduk HAOP04a) | P1 | S. Dillon <i>in litt.</i> (29/07/2021). |
| <i>Portulaca</i> sp. Kununurra (M.D. Barrett MDB 5981) | | M.D. Barrett <i>in litt.</i> (28/01/2021). |
| <i>Pterostylis occulta</i> G.Brockman & C.J.French | | See Brockman & French (2021). |
| <i>Ptilotus crinitus</i> T.Hammer & R.W.Davis | | See Hammer & Davis (2021). |
| <i>Sesamum indicum</i> L. | * | New naturalised record for WA. A. Markey <i>in litt.</i> (10/02/2021). |
| <i>Sesuvium portulacastrum</i> (L.) L. subsp. <i>portulacastrum</i> | | New record for WA. See CHAH (2021a). |
| <i>Stenanthemum</i> sp. Eganu (S. Patrick 4537) | P2 | K.R. Thiele <i>in litt.</i> (02/03/2021). |
| <i>Streptoglossa</i> sp. South Coast (R.M. Hoggart 16/1113) | P2 | M. Hislop <i>in litt.</i> (31/12/2020). |
| <i>Styphelia</i> sp. Kirkalocka (A.S. George 17738) | P1 | M. Hislop <i>in litt.</i> (21/04/2021). |

| New Name | Status | Comments |
|---|--------|---|
| <i>Styphelia</i> sp. Watheroo (M. Hislop 4324) | | M. Hislop <i>in litt.</i> (29/11/2021). |
| <i>Swainsona katjarra</i> R.W.Davis & T.Hammer | P1 | See Davis & Hammer (2020). |
| <i>Swainsona</i> sp. Karara (C. Godden & J. Hruban 24-26) | P1 | R. Davis <i>in litt.</i> (28/04/2021). |
| <i>Tephrosia sabulosa</i> R.Butcher | | See Butcher (2021b). |
| <i>Thelymitra</i> sp. South coast (G. Byrne 5133) | P2 | A.P. Brown <i>in litt.</i> (30/08/2021). |
| <i>Themeda</i> sp. Panorama (J. Nelson et al. NS 102) | P1 | P. Jayasekara <i>in litt.</i> (14/07/2020). |
| <i>Tricostularia drummondii</i> (Steud.) R.L.Barrett & K.L.Wilson | | See Barrett <i>et al.</i> (2021b). |
| <i>Tricostularia</i> sp. Albany (R.L. Barrett & K.L. Wilson RLB 5342) | | See Barrett <i>et al.</i> (2021b). |
| <i>Tricostularia</i> sp. Mogumber (A. Harris s.n., 23/12/2015) | | See Barrett <i>et al.</i> (2021b). |
| <i>Tricostularia</i> sp. Porongurup (I. Abbott 18) | P1 | See Barrett <i>et al.</i> (2021b). |
| <i>Tricostularia</i> sp. Two Peoples Bay (G. Wardell-Johnson GWJ 114) | | See Barrett <i>et al.</i> (2021b). |

Table 2. Changes to existing entries in Western Australia's vascular plant census during 2021. Excluded taxon = a name used in the botanical literature that refers to a taxon never occurring in WA; misapplied name = a name used in the botanical literature but now considered to refer to one or more different WA taxa; nomenclatural synonym = a superseded name based on the same type specimen as the accepted name; taxonomic synonym = a superseded name based on a different type specimen to the accepted name; orthographic variant = mis-spelling of a name in original publication; *in litt.* = in correspondence; *in sched.* = on herbarium sheet/label. Status: * = naturalised; X, T, P1–P4 = Department of Biodiversity, Conservation and Attractions Conservation Codes for Western Australian flora (Smith & Jones 2018; Western Australian Herbarium 1998–).

| Old Name | New Name | Status | Comments |
|--|---|--------|---|
| <i>Acacia catenulata</i> C.T.White subsp. <i>catenulata</i> | n/a | | Excluded taxon. This taxon does not occur in WA. See Maslin & van Leeuwen (2008). |
| <i>Acacia karina</i> Maslin & Buscumb | <i>Acacia karinae</i> Maslin & Buscumb | P1 | Orthographic variant. J.M. Huisman <i>in litt.</i> (29/05/2019). |
| <i>Acacia</i> sp. small seed (B.R. Maslin 7830) | <i>Acacia acuminata</i> subsp. small seed (B.R. Maslin 7830) | | Name synonymised. B.R. Maslin <i>in sched.</i> (15/09/2021). |
| <i>Actinoschoenus arthrotyloides</i> (W.Fitzg.) K.L.Clarke, K.L.Wilson & J.J.Bruhl | <i>Scleroschoenus arthrotyloides</i> (W.Fitzg.) K.L.Wilson & J.J.Bruhl | | Nomenclatural synonym. See Larridon <i>et al.</i> (2021). |
| <i>Actinoschoenus glabrispiculus</i> Rye, R.L.Barrett & M.D.Barrett | <i>Scleroschoenus glabrispiculus</i> (Rye, R.L.Barrett & M.D.Barrett) K.L.Wilson & J.J.Bruhl | P3 | Nomenclatural synonym. See Larridon <i>et al.</i> (2021). |

| Old Name | New Name | Status | Comments |
|--|--|--------|---|
| <i>Actinoschoenus pentagonus</i> Rye, R.L.Barrett & M.D.Barrett | <i>Scleroschoenus pentagonus</i> (Rye, R.L.Barrett & M.D.Barrett) K.L.Wilson & J.J.Bruhl | | Nomenclatural synonym. See Larridon <i>et al.</i> (2021). |
| <i>Actinoschoenus quadricostatus</i> Rye, R.L.Barrett & M.D.Barrett | <i>Scleroschoenus quadricostatus</i> (Rye, R.L.Barrett & M.D.Barrett) K.L.Wilson & J.J.Bruhl | P1 | Nomenclatural synonym. See Larridon <i>et al.</i> (2021). |
| <i>Actinoschoenus ramosus</i> Rye, R.L.Barrett & M.D.Barrett | <i>Scleroschoenus ramosus</i> (Rye, R.L.Barrett & M.D.Barrett) K.L.Wilson & J.J.Bruhl | P3 | Nomenclatural synonym. See Larridon <i>et al.</i> (2021). |
| <i>Aptenia cordifolia</i> (L.f.) Schwantes | <i>Mesembryanthemum cordifolium</i> L.f. | * | Nomenclatural synonym. See Klak <i>et al.</i> (2007). |
| <i>Arthrostylis aphylla</i> R.Br. | n/a | | Excluded taxon. This taxon does not occur in WA. See Larridon <i>et al.</i> (2021). |
| <i>Avellinia michelii</i> (Savi) Parl. | <i>Avellinia festucoides</i> (Link) Valdes & H.Scholz | * | Taxonomic synonym. See CHAH (2021b). |
| <i>Baumea acuta</i> (Labill.) Palla | <i>Machaerina acuta</i> (Labill.) J.Kern | | Nomenclatural synonym. See Wilson (2015). |
| <i>Baumea arthropphylla</i> (Nees) Boeckeler | <i>Machaerina arthropphylla</i> (Nees) T.Koyama | | Nomenclatural synonym. See Wilson (2015). |
| <i>Baumea articulata</i> (R.Br.) S.T.Blake | <i>Machaerina articulata</i> (R.Br.) T.Koyama | | Nomenclatural synonym. See Wilson (2015). |
| <i>Baumea juncea</i> (R.Br.) Palla | <i>Machaerina juncea</i> (R.Br.) T.Koyama | | Nomenclatural synonym. See Wilson (2015). |
| <i>Baumea laxa</i> (Nees) Boeckeler | <i>Machaerina laxa</i> (Nees) T.Koyama | | Nomenclatural synonym. See Wilson (2015). |
| <i>Baumea preissii</i> Nees | <i>Machaerina preissii</i> (Nees) L.A.S.Johnson & T.Koyama | | Nomenclatural synonym. See Wilson (2015). |
| <i>Baumea riparia</i> (Nees) Boeckeler | <i>Machaerina arthropphylla</i> (Nees) T.Koyama | | Taxonomic synonym. R.L. Barrett <i>in litt.</i> (27/07/2021). |
| <i>Baumea rubiginosa</i> (Spreng.) Boeckeler | <i>Machaerina rubiginosa</i> (Spreng.) T.Koyama | | Nomenclatural synonym. See Wilson (2015). |
| <i>Baumea vaginalis</i> (Benth.) S.T.Blake | <i>Machaerina vaginalis</i> (Benth.) T.Koyama | | Nomenclatural synonym. See Wilson (2015). |
| <i>Baumea</i> sp. Blackwood (R. Davis 7681) | <i>Machaerina</i> sp. Blackwood (R. Davis 7681) | | Name synonymised. See Wilson (2015). |
| <i>Boronia tenuis</i> (Lindl.) Benth. | <i>Cyanothamnus tenuis</i> Lindl. | P4 | Nomenclatural synonym. See Duretto <i>et al.</i> (2020). |
| <i>Caladenia</i> sp. Bulbarnet (G. Brockman GBB 2880) | <i>Caladenia multiplex</i> A.P.Br. & R.D.Phillips | | Taxon formally published. See Brown & Phillips (2021). |
| <i>Calamphoreus inflatus</i> (C.A.Gardner) Chinnock | <i>Eremophila inflata</i> C.A.Gardner | P4 | Nomenclatural synonym. See Fowler <i>et al.</i> (2021). |
| <i>Cenchrus elymoides</i> var. <i>brevisetosus</i> B.K.Simon | <i>Cenchrus brevisetosus</i> (B.K.Simon) B.K.Simon | | Nomenclatural synonym. See Simon (2010). |
| <i>Cenchrus elymoides</i> F.Muell. var. <i>elymoides</i> | <i>Cenchrus elymoides</i> F.Muell. | | Nomenclatural synonym. No varieties recognised. See Simon (2010). |
| <i>Corynotheca micrantha</i> var. <i>acanthoclada</i> (F.Muell.) R.J.F.Hend. | <i>Corynotheca acanthoclada</i> (F.Muell.) Benth. | P1 | Nomenclatural synonym. See Barrett <i>et al.</i> (2021c). |

| Old Name | New Name | Status | Comments |
|---|---|--------|--|
| <i>Corynotheca micrantha</i> var. <i>divaricata</i> R.J.F.Hend. | <i>Corynotheca divaricata</i> (R.J.F.Hend.) R.L.Barrett & T.Macfarlane | | Nomenclatural synonym. See Barrett <i>et al.</i> (2021c). |
| <i>Corynotheca micrantha</i> var. <i>elongata</i> R.J.F.Hend. | <i>Corynotheca elongata</i> (R.J.F.Hend.) R.L.Barrett & T.Macfarlane | | Nomenclatural synonym. See Barrett <i>et al.</i> (2021c). |
| <i>Corynotheca micrantha</i> var. <i>gracilis</i> R.J.F.Hend. | <i>Corynotheca gracilis</i> (R.J.F.Hend.) R.L.Barrett & T.Macfarlane | | Nomenclatural synonym. See Barrett <i>et al.</i> (2021c). |
| <i>Corynotheca micrantha</i> (Lindl.) Druce var. <i>micrantha</i> | <i>Corynotheca micrantha</i> (Lindl.) Druce | | Nomenclatural synonym. No varieties recognised. See Barrett <i>et al.</i> (2021c). |
| <i>Corynotheca micrantha</i> var. <i>panda</i> R.J.F.Hend. | <i>Corynotheca panda</i> (R.J.F.Hend.) R.L.Barrett & T.Macfarlane | | Nomenclatural synonym. See Barrett <i>et al.</i> (2021c). |
| <i>Crassula colorata</i> var. <i>miriamiae</i> (Ostenf.) Toelken | <i>Crassula colorata</i> var. <i>miriamae</i> (Ostenf.) Toelken | P2 | Orthographic variant. See CHAH (2007). |
| <i>Cyanicula gertrudiae</i> (Ostenf.) Hopper & A.P.Br. | <i>Cyanicula gertrudae</i> (Ostenf.) Hopper & A.P.Br. | | Orthographic variant. See CHAH (2018a). |
| <i>Cyathostemma glabrum</i> (Span.) Utteridge | <i>Uvaria glabra</i> Span. | | Nomenclatural synonym. See Turner (2018). |
| <i>Cyathostemma micranthum</i> (A.DC.) J.Sinclair | <i>Uvaria micrantha</i> (A.DC.) Hook.f. & Thomson | | Nomenclatural synonym. See Turner (2018). |
| <i>Dendrobium affine</i> (Decne.) Steud. | <i>Dendrobium dicuphum</i> F.Muell. | | Misapplied name. See CHAH (2018b). |
| <i>Desmodium brownii</i> Schindl. | <i>Grona brownii</i> (Schindl.) H.Ohashi & K.Ohashi | | Nomenclatural synonym. See Ohashi & Ohashi (2018). |
| <i>Desmodium campylocaulon</i> Benth. | <i>Desmodiopsis campylocaulon</i> (Benth.) H.Ohashi & K.Ohashi | | Nomenclatural synonym. See Ohashi <i>et al.</i> (2018). |
| <i>Desmodium filiforme</i> Zoll. & Moritzi | <i>Grona filiformis</i> (Zoll. & Moritzi) H.Ohashi & K.Ohashi | | Nomenclatural synonym. See Ohashi & Ohashi (2018). |
| <i>Desmodium flagellare</i> Benth. | <i>Grona flagellaris</i> (Benth.) H.Ohashi & K.Ohashi | P1 | Nomenclatural synonym. See Ohashi & Ohashi (2018). |
| <i>Desmodium gangeticum</i> (L.) DC. | <i>Pleurolobus gangeticus</i> (L.) J.St.-Hil. | | Nomenclatural synonym. See Ohashi <i>et al.</i> (2018). |
| <i>Desmodium glareosum</i> Pedley | <i>Grona glareosa</i> (Pedley) H.Ohashi & K.Ohashi | | Nomenclatural synonym. See Ohashi & Ohashi (2018). |
| <i>Desmodium hannii</i> Schindl. | <i>Grona hannii</i> (Schindl.) H.Ohashi & K.Ohashi | | Nomenclatural synonym. See Ohashi & Ohashi (2018). |
| <i>Desmodium heterocarpon</i> (L.) DC. | <i>Grona heterocarpa</i> (L.) H.Ohashi & K.Ohashi | | Nomenclatural synonym. See Ohashi & Ohashi (2018). |
| <i>Desmodium heterocarpon</i> var. <i>strigosum</i> Meeuwen | <i>Grona heterocarpa</i> var. <i>strigosa</i> (Meeuwen) H.Ohashi & K.Ohashi | | Nomenclatural synonym. See Ohashi & Ohashi (2018). |
| <i>Desmodium muelleri</i> Benth. | <i>Grona muelleri</i> (Benth.) H.Ohashi & K.Ohashi | | Nomenclatural synonym. See Ohashi & Ohashi (2018). |
| <i>Desmodium pullenii</i> Pedley | <i>Grona pullenii</i> (Pedley) H.Ohashi & K.Ohashi | P1 | Nomenclatural synonym. See Ohashi & Ohashi (2018). |
| <i>Desmodium pycnotrichum</i> Pedley | <i>Grona pycnotricha</i> (Pedley) H.Ohashi & K.Ohashi | | Nomenclatural synonym. See Ohashi & Ohashi (2018). |

| Old Name | New Name | Status | Comments |
|---|---|--------|---|
| <i>Desmodium trichostachyum</i> Benth. | <i>Grona trichostachya</i> (Benth.) H.Ohashi & K.Ohashi | | Nomenclatural synonym. See Ohashi & Ohashi (2018). |
| <i>Desmodium triflorum</i> (L.) DC. | <i>Grona triflora</i> (L.) H.Ohashi & K.Ohashi | * | Nomenclatural synonym. See Ohashi & Ohashi (2018). |
| <i>Dicrastylis</i> sp. Peron Peninsula (M.E. Trudgen 7373) | <i>Dicrastylis soliparma</i> Rye & Trudgen | | Name synonymised. See Rye & Trudgen (1998). |
| <i>Dimorphocalyx australiensis</i> C.T.White | <i>Tritaxis australiensis</i> S.Moore | | Taxonomic synonym. See Yu <i>et al.</i> (2019). |
| <i>Diocirea acutifolia</i> Chinnock | <i>Eremophila acutifolia</i> (Chinnock) R.Fowler | P3 | Nomenclatural synonym. See Fowler <i>et al.</i> (2021). |
| <i>Diocirea microphylla</i> Chinnock | <i>Eremophila microphylla</i> (Chinnock) R.Fowler | P3 | Nomenclatural synonym. See Fowler <i>et al.</i> (2021). |
| <i>Diocirea ternata</i> Chinnock | <i>Eremophila ternata</i> (Chinnock) R.Fowler | | Nomenclatural synonym. See Fowler <i>et al.</i> (2021). |
| <i>Diocirea violacea</i> Chinnock | <i>Eremophila violacea</i> (Chinnock) R.Fowler | | Nomenclatural synonym. See Fowler <i>et al.</i> (2021). |
| <i>Diuris decremenda</i> D.L.Jones & C.J.French | <i>Diuris decrementum</i> D.L.Jones & C.J.French | | Orthographic variant. A.S. George <i>in litt.</i> (13/12/2021). |
| <i>Dodonaea ptarmicaefolia</i> Turcz. | <i>Dodonaea ptarmicifolia</i> Turcz. | | Orthographic variant. See CHAH (2005a). |
| <i>Dopatrium junceum</i> (Roxb.) Benth. | n/a | P1 | Name made current. Taxon reinstated. R.L. Barrett <i>in litt.</i> (21/02/2021). |
| <i>Eragrostis amabilis</i> (L.) Nees var. <i>amabilis</i> | <i>Eragrostis tenella</i> (L.) Roem. & Schult. | * | Taxonomic synonym. No varieties recognised. See Germplasm Resources Information Network (2021). |
| <i>Eremophila glabra</i> subsp. Wongan Hills (M. Hislop 2079) | <i>Eremophila rarissima</i> Buirchell & A.P.Br. | P1 | Taxon formally published. See Buirchell & Brown (2021). |
| <i>Eriochilus dilatatus</i> subsp. <i>magnus</i> Hopper & A.P.Br. | <i>Eriochilus dilatatus</i> Lindl. subsp. <i>dilatatus</i> | | Taxonomic synonym. See Brundrett & Hammer (2020). |
| <i>Eriochilus dilatatus</i> subsp. <i>multiflorus</i> (Lindl.) Hopper & A.P.Br. | <i>Eriochilus dilatatus</i> Lindl. subsp. <i>dilatatus</i> | | Taxonomic synonym. See Brundrett & Hammer (2020). |
| <i>Eriochilus dilatatus</i> subsp. <i>orientalis</i> Hopper & A.P.Br. | <i>Eriochilus dilatatus</i> subsp. <i>brevifolius</i> (Benth.) Hopper & A.P.Br. | | Taxonomic synonym. See Brundrett & Hammer (2020). |
| <i>Eriochilus dilatatus</i> subsp. <i>undulatus</i> Hopper & A.P.Br. | <i>Eriochilus dilatatus</i> subsp. <i>brevifolius</i> (Benth.) Hopper & A.P.Br. | | Taxonomic synonym. See Brundrett & Hammer (2020). |
| <i>Eucalyptus comitae-vallis</i> Maiden | <i>Eucalyptus cometae-vallis</i> Maiden | | Orthographic variant. See CHAH (2021c). |
| <i>Festuca arundinacea</i> Schreb. | <i>Lolium arundinaceum</i> (Schreb.) Darbysh. | * | Nomenclatural synonym. See Banfi <i>et al.</i> (2017). |
| <i>Festuca pratensis</i> Huds. | <i>Lolium pratense</i> (Huds.) Darbysh. | * | Nomenclatural synonym. See Banfi <i>et al.</i> (2017). |
| <i>Ficus geniculata</i> Kurz | n/a | | Excluded taxon. This taxon does not occur in WA. See CHAH (2016). |
| <i>Ficus virens</i> var. <i>sublanceolata</i> (Miq.) Corner | <i>Ficus virens</i> Aiton | | Taxonomic synonym. See CHAH (2005b). |

| Old Name | New Name | Status | Comments |
|---|---|--------|--|
| <i>Fimbristylis macrantha</i> Boeckeler | <i>Abildgaardia macrantha</i> (Boeckeler) Goetgh. | | Nomenclatural synonym. See Larridon <i>et al.</i> (2021). |
| <i>Fimbristylis oxystachya</i> F.Muell. | <i>Abildgaardia oxystachya</i> (F.Muell.) K.L.Wilson & J.J.Bruhl | | Nomenclatural synonym. See Larridon <i>et al.</i> (2021). |
| <i>Fimbristylis pachyptera</i> S.T.Blake | <i>Abildgaardia pachyptera</i> (S.T.Blake) K.L.Wilson & J.J.Bruhl | P1 | Nomenclatural synonym. See Larridon <i>et al.</i> (2021). |
| <i>Gamochaeta coarctata</i> (Willd.) Kerguelen | <i>Gamochaeta americana</i> (Mill.) Wedd. | * | Taxonomic synonym. See Freire <i>et al.</i> (2021). |
| <i>Gastrolobium asperum</i> G.Chandler & Crisp ms | <i>Gastrolobium</i> sp. <i>Asperum</i> (F. Hort 2864) | | Name synonymised. M. Hislop <i>in litt.</i> (13/05/2021). |
| <i>Gilruthia osbornii</i> Ewart & Jean White | <i>Gilruthia osbornei</i> Ewart & Jean White | | Orthographic variant. See Sharr & George (2019). |
| <i>Gomphrena</i> sp. Cambridge Gulf (K.F. Kenneally 11899 K) | <i>Gomphrena longistyla</i> R.W.Davis, J.Palmer & T.Hammer | P2 | Taxon formally published. See Davis <i>et al.</i> (2021). |
| <i>Gomphrena</i> sp. Martins Well (K.F. Kenneally 6116) | <i>Gomphrena axillaris</i> R.W.Davis & J.Palmer | P1 | Name synonymised. See Davis <i>et al.</i> (2021). |
| <i>Grevillea</i> sp. Gunapin (F. Hort 308) | <i>Grevillea hortiorum</i> Olde | | Taxon formally published. See Olde (2021a). |
| <i>Grevillea</i> sp. Shark Bay (N.H. Speck 24/09/1953) | <i>Grevillea speckiana</i> Olde | P1 | Taxon formally published. See Olde (2021c). |
| <i>Grevillea</i> sp. Stirling Range (D.J. McGillivray 3488 & A.S. George) | <i>Grevillea pieroniae</i> Olde | P2 | Taxon formally published. See Olde (2020). |
| <i>Indigofera</i> sp. Bungaroo Creek (S. van Leeuwen 4301) | <i>Indigofera rivularis</i> Peter G. Wilson | P3 | Taxon formally published. See Wilson (2021). |
| <i>Isotropis</i> sp. Yalgoo (S. Patrick 2375) | <i>Isotropis petrensis</i> R.W.Davis & Wege | P1 | Taxon formally published. See Davis & Wege (2021). |
| <i>Lachenalia aloides</i> (L.f.) Engl. | <i>Lachenalia flava</i> Andrews | * | Misapplied name. G.J. Keighery <i>in litt.</i> (21/06/2021). |
| <i>Lachnostachys albicans</i> Hook. | <i>Apatelantha albicans</i> (Hook.) T.C.Wilson & Henwood | | Nomenclatural synonym. See Wilson <i>et al.</i> (2021). |
| <i>Lasiopetalum</i> sp. Coorow (E. Ried 101) | <i>Lasiopetalum biloculatum</i> K.A.Sheph. & C.F.Wilkins | | Taxon formally published. See Shepherd & Wilkins (2021). |
| <i>Lasiopetalum</i> sp. Watheroo (K. Shepherd & C. Wilkins KS 220) | <i>Lasiopetalum erectifolium</i> K.A.Sheph. & C.F.Wilkins | | Taxon formally published. See Shepherd & Wilkins (2021). |
| <i>Leucopogon</i> sp. Badgingarra (R. Davis 421) | <i>Styphelia undulata</i> Hislop | P2 | Taxon formally published. See Hislop (2021). |
| <i>Lipocarpha microcephala</i> (R.Br.) Kunth | <i>Cyperus leptocarpus</i> (F.Muell.) Bauters | | Taxonomic synonym. See Bauters <i>et al.</i> (2014). |
| <i>Marsdenia angustata</i> P.I.Forst. | <i>Gymnema erectum</i> (F.Muell.) P.I.Forst. | | Nomenclatural synonym. See Forster (2021). |
| <i>Marsdenia australis</i> (R.Br.) Druce | <i>Leichhardtia australis</i> R.Br. | | Nomenclatural synonym. See Forster (2021). |
| <i>Marsdenia geminata</i> (R.Br.) P.I.Forst. | <i>Gymnema geminatum</i> R.Br. | | Nomenclatural synonym. See Forster (2021). |

| Old Name | New Name | Status | Comments |
|--|--|--------|---|
| <i>Marsdenia glandulifera</i> C.T.White | <i>Leichhardtia glandulifera</i> (C.T.White) P.I.Forst. | P1 | Nomenclatural synonym. See Forster (2021). |
| <i>Marsdenia graniticola</i> P.I.Forst. | <i>Gymnema graniticola</i> (P.I.Forst.) P.I.Forst. | | Nomenclatural synonym. See Forster (2021). |
| <i>Marsdenia hemiptera</i> Rchb.f. | <i>Leichhardtia racemosa</i> (Benth.) P.I.Forst. | P1 | Taxonomic synonym. See Forster (2021). |
| <i>Marsdenia pleiadenia</i> (F.Muell.) P.I.Forst. | <i>Gymnema pleiadenium</i> F.Muell. | | Nomenclatural synonym. See Forster (2021). |
| <i>Marsdenia trinervis</i> (R.Br.) P.I.Forst. | <i>Gymnema trinerve</i> R.Br. | | Nomenclatural synonym. See Forster (2021). |
| <i>Marsdenia velutina</i> R.Br. | <i>Leichhardtia velutina</i> (R.Br.) P.I.Forst. | | Nomenclatural synonym. See Forster (2021). |
| <i>Marsdenia viridiflora</i> R.Br. | <i>Leichhardtia viridiflora</i> (R.Br.) P.I.Forst. | | Nomenclatural synonym. See Forster (2021). |
| <i>Marsdenia viridiflora</i> subsp. <i>tropica</i> P.I.Forst. | <i>Leichhardtia viridiflora</i> subsp. <i>tropica</i> (P.I.Forst.) P.I.Forst. | | Nomenclatural synonym. See Forster (2021). |
| <i>Newcastelia insignis</i> E.Pritz. | <i>Apatelantha insignis</i> (E.Pritz.) T.C.Wilson & Henwood | P2 | Nomenclatural synonym. See Wilson <i>et al.</i> (2021). |
| <i>Newcastelia</i> sp. Hamersley Range (S. van Leeuwen 4264) | <i>Newcastelia clavipetala</i> T.C.Wilson & Radunz | | Taxon formally published. See Wilson <i>et al.</i> (2021). |
| <i>Nicotiana occidentalis</i> subsp. <i>hesperis</i> (N.T.Burb.) P.Horton | <i>Nicotiana hesperis</i> N.T.Burb. | | Nomenclatural synonym. See Chase & Christenhusz (2021d). |
| <i>Nicotiana occidentalis</i> subsp. <i>obliqua</i> N.T.Burb. | <i>Nicotiana obliqua</i> (N.T.Burb.) M.W.Chase & Christenh. | | Nomenclatural synonym. See Chase <i>et al.</i> (2021d). |
| <i>Nicotiana occidentalis</i> H.-M.Wheeler subsp. <i>occidentalis</i> | <i>Nicotiana occidentalis</i> H.-M.Wheeler | | Nomenclatural synonym. No subspecies recognised. See Chase <i>et al.</i> (2021a). |
| <i>Nicotiana rosulata</i> subsp. <i>ingulba</i> (J.M.Black) P.Horton | <i>Nicotiana ingulba</i> J.M.Black | | Nomenclatural synonym. See Chase <i>et al.</i> (2021b). |
| <i>Nicotiana rosulata</i> (S.Moore) Domin subsp. <i>rosulata</i> | <i>Nicotiana rosulata</i> (S.Moore) Domin | | Nomenclatural synonym. See Chase & Christenhusz (2021a). |
| <i>Olex pendula</i> L.S.Sm. | n/a | | Name made current. Taxon reinstated. R. Davis <i>in sched.</i> (01/12/2021). |
| <i>Ornithogalum longibracteatum</i> Jacq. | <i>Albuca bracteata</i> (Thunb.) J.C.Manning & Goldblatt | * | Taxonomic synonym. See Manning <i>et al.</i> (2009). |
| <i>Pandorea doratoxylon</i> (J.M.Black) J.M.Black | n/a | | Name made current. Taxon reinstated. See Keighery & Keighery (2021). |
| <i>Physopsis chrysotricha</i> (F.Muell.) Rye | <i>Apatelantha chrysotricha</i> (F.Muell.) T.C.Wilson & Henwood | P2 | Nomenclatural synonym. See Wilson <i>et al.</i> (2021). |
| <i>Physopsis lachnostachya</i> C.A.Gardner | <i>Apatelantha lachnostachya</i> (C.A.Gardner) T.C.Wilson & Henwood | | Nomenclatural synonym. See Wilson <i>et al.</i> (2021). |
| <i>Physopsis viscida</i> (E.Pritz.) Rye | <i>Apatelantha viscida</i> (E.Pritz.) T.C.Wilson & Henwood | | Nomenclatural synonym. See Wilson <i>et al.</i> (2021). |
| <i>Piptatherum miliaceum</i> (L.) Coss. | <i>Oloptum miliaceum</i> (L.) M.Röser & H.R.Hamasha | * | Nomenclatural synonym. See Peterson <i>et al.</i> (2019). |

| Old Name | New Name | Status | Comments |
|---|--|--------|---|
| <i>Podolepis capillaris</i> (Steetz) Diels | <i>Siemssenia capillaris</i> Steetz | | Nomenclatural synonym. See Jeanes (2021). |
| <i>Podolepis kendallii</i> (F.Muell.) F.Muell. | <i>Walshia kendallii</i> (F.Muell.) Jeanes | | Nomenclatural synonym. See Jeanes (2021). |
| <i>Podolepis lessonii</i> (Cass.) Benth. | <i>Panaetia lessonii</i> Cass. | | Nomenclatural synonym. See Jeanes (2021). |
| <i>Podolepis microcephala</i> Benth. | <i>Siemssenia microcephala</i> (Benth.) Jeanes | | Nomenclatural synonym. See Jeanes (2021). |
| <i>Podolepis tepperi</i> (F.Muell.) D.A.Cooke | <i>Panaetia tepperi</i> (F.Muell.) Jeanes | | Nomenclatural synonym. See Jeanes (2021). |
| <i>Potamogeton tricarinatus</i> F.Muell. & A.Benn. | n/a | | Excluded taxon. This taxon does not occur in WA. See Papassotiriou <i>et al.</i> (2011). |
| <i>Pultenaea</i> sp. Mt Lesueur (L.A. Orthia 86) | <i>Pultenaea</i> sp. Mt Lesueur (J.S. Beard 7827) | P2 | Name synonymised. Correction to voucher-specimen identifier. See Orthia <i>et al.</i> (2005). |
| <i>Rinzia polystemonea</i> (F.Muell.) Rye | <i>Rinzia polystemona</i> (F.Muell.) Rye | | Orthographic variant. See CHAH (2021d). |
| <i>Scabiosa atropurpurea</i> L. | <i>Sixalix atropurpurea</i> (L.) Greuter & Burdet | * | Nomenclatural synonym. See Del Guacchio <i>et al.</i> (2018). |
| <i>Schizachyrium mitchelliana</i> B.K.Simon | <i>Cymbopogon procerus</i> (R.Br.) Domin | | Taxonomic synonym. See Thompson & Forster (2021). |
| <i>Schoenus grandiflorus</i> (Lehm.) F.Muell. | <i>Ammothryon grandiflorum</i> (Lehm.) R.L.Barrett, K.L.Wilson & J.J.Bruhl | | Nomenclatural synonym. See Barrett <i>et al.</i> (2021b). |
| <i>Scholtzia denticulata</i> Rye | <i>Scholtzia kalbarri</i> U.B.Deshmukh | P2 | Nomenclatural synonym. See Deshmukh (2021). |
| <i>Silene longicaulis</i> Lag. | n/a | * | Excluded taxon. This taxon is not considered naturalised. No collections recorded for WA. |
| <i>Smilax leucophylla</i> Blume | n/a | | This taxon does not occur in WA. See CHAH (2021e). |
| <i>Staurogyne leptocaulis</i> Bremek. | <i>Staurogyne spatulata</i> (Blume) Koord. | | Taxonomic synonym. See Daniel & McDade (2014). |
| <i>Staurogyne leptocaulis</i> subsp. <i>decumbens</i> R.M.Barker | <i>Staurogyne spatulata</i> (Blume) Koord. | | Taxonomic synonym. See Daniel & McDade (2014). |
| <i>Tephrosia</i> sp. Durack River (C.A. Gardner 9938) | <i>Tephrosia cowiei</i> R.Butcher | P1 | Taxon formally published. See Butcher (2021a). |
| <i>Tephrosia</i> sp. Magazine Hill (P. Jones 365) | <i>Tephrosia lithosperma</i> R.Butcher & Cowie | P1 | Name synonymised. See Butcher & Cowie (2021). |
| <i>Tephrosia</i> sp. Willowra (G.M. Chippendale 4809) | <i>Tephrosia insolens</i> R.Butcher & Cowie | | Taxon formally published. See Butcher & Cowie (2021). |
| <i>Tephrosia</i> sp. Yampi (A.N. Start per R.L. Barrett RLB 2291) | <i>Tephrosia funicularis</i> R.Butcher | P3 | Taxon formally published. See Butcher (2021a). |
| <i>Tetraria australiensis</i> C.B.Clarke | <i>Morelotia australiensis</i> (C.B.Clarke) R.L.Barrett & K.L.Wilson | T | Nomenclatural synonym. See Barrett <i>et al.</i> (2021b). |
| <i>Tetraria capillaris</i> (F.Muell.) J.M.Black | <i>Netrostylis capillaris</i> (F.Muell.) R.L.Barrett, J.J.Bruhl & K.L.Wilson | | Nomenclatural synonym. See Barrett <i>et al.</i> (2021a). |

| Old Name | New Name | Status | Comments |
|--|--|--------|--|
| <i>Tetraria microcarpa</i> S.T.Blake | <i>Morelotia microcarpa</i> (S.T.Blake) R.L.Barrett & K.L.Wilson | | Nomenclatural synonym. See Barrett <i>et al.</i> (2021b). |
| <i>Tetraria octandra</i> (Nees) Kük. | <i>Morelotia octandra</i> (Nees) R.L.Barrett & J.J.Bruhl | | Nomenclatural synonym. See Barrett <i>et al.</i> (2021b). |
| <i>Tetraria</i> sp. Blackwood River (A.R. Annels 3043) | <i>Netrostylis</i> sp. Blackwood River (A.R. Annels 3043) | P3 | Name synonymised. R.L. Barrett <i>in litt.</i> (19/04/2021). |
| <i>Tetraria</i> sp. Chandala (G.J. Keighery 17055) | <i>Netrostylis</i> sp. Chandala (G.J. Keighery 17055) | P2 | Name synonymised. R.L. Barrett <i>in litt.</i> (19/04/2021). |
| <i>Tetraria</i> sp. Jarrah Forest (R. Davis 7391) | <i>Netrostylis</i> sp. Jarrah Forest (R. Davis 7391) | | Name synonymised. R.L. Barrett <i>in litt.</i> (19/04/2021). |
| <i>Tetraria</i> sp. Mt Madden (C.D. Turley 40 BP/897) | <i>Netrostylis</i> sp. Mt Madden (C.D. Turley 40 BP/897) | | Name synonymised. R.L. Barrett <i>in litt.</i> (19/04/2021). |
| <i>Tetraria</i> sp. Nannup (P.A. Jurjevich 1133) | <i>Netrostylis</i> sp. Nannup (P.A. Jurjevich 1133) | P1 | Name synonymised. R.L. Barrett <i>in litt.</i> (19/04/2021). |
| <i>Tetraria</i> sp. Warren (M. McCallum Webster 23/2/1979) | <i>Netrostylis</i> sp. Warren (M. McCallum Webster 23/2/1979) | P1 | Name synonymised. R.L. Barrett <i>in litt.</i> (19/04/2021). |
| <i>Thinopyrum ponticum</i> (Podp.) Barkworth & D.R.Dewey | <i>Thinopyrum obtusiflorum</i> (DC.) Banfi | * | Taxonomic synonym. See Banfi (2018). |
| <i>Tricostularia</i> sp. Hopetoun (M. Bennett 646) | <i>Tricostularia bennettiana</i> R.L.Barrett & K.L.Wilson | | Taxon formally published. See Barrett <i>et al.</i> (2021b). |
| <i>Tricostularia</i> sp. Lake King (A.M. Coates 2298) | <i>Tricostularia lepschii</i> R.L.Barrett & K.L.Wilson | P2 | Taxon formally published. See Barrett <i>et al.</i> (2021b). |
| <i>Tricostularia</i> sp. Ongerup (L. Strahan 409) | <i>Tricostularia newbeyi</i> R.L.Barrett & K.L.Wilson | | Taxon formally published. See Barrett <i>et al.</i> (2021b). |
| <i>Tricostularia</i> sp. south coast (R.T. Wills 1423) | <i>Tricostularia sandifordiana</i> R.L.Barrett & K.L.Wilson | | Taxon formally published. See Barrett <i>et al.</i> (2021b). |
| <i>Tricostularia</i> sp. Wellstead (R. Davis 302) | <i>Tricostularia davisii</i> R.L.Barrett & K.L.Wilson | | Taxon formally published. See Barrett <i>et al.</i> (2021b). |
| <i>Utricularia arnhemica</i> P.Taylor | <i>Utricularia magna</i> R.W.Jobson & M.D.Barrett | P2 | Misapplied name. See Jobson <i>et al.</i> (2018). |

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References

- Banfi, E. (2018). A survey of the *Elymus* L. *s.l.* species complex (Triticeae, Poaceae) in Italy: taxa and nothotaxa, new combinations and identification key. *Natural History Sciences* 5(2): 57–64.
- Banfi, E.A., Galasso, G., Foggi, B., Kopecký, D. & Ardenghi, N.M.G. (2017). From *Schedonorus* and *Micropyropsis* to *Lolium* (Poaceae: Loliinae): New combinations and typifications. *Taxon* 66: 708–717.
- Barrett, R.L., Bruhl, J.J. & Wilson, K.L. (2021a). *Netrostylis*, a new genus of Australasian Cyperaceae removed from *Tetraria*. *Telopea* 24: 53–60.

- Barrett, R.L., Bruhl, J.J. & Wilson, K.L. (2021b). Revision of generic concepts in Schoeneae subtribe Tricostulariinae (Cyperaceae) with a new Australian genus *Ammothryon* and new species of *Tricostularia*. *Telopea* 24: 61–169.
- Barrett, R.L., Macfarlane, T.D. & Keighery, G.J. (2021c). Taxonomic revision of *Corynotheca* (Hemerocallidaceae/Asphodelaceae). *Telopea* 24: 7–52.
- Bauters, K., Larridon, I., Reynders, M., Asselman, P., Vrijdaghs, A., Muasya, A.M., Simpson, D.A. & Goetghebeur, P. (2014). A new classification for *Lipocarpus* and *Folkiella* as infrageneric taxa of *Cyperus* s.l. (Cyperaceae, Cyperoideae, Cyperaceae): insights from species tree reconstruction supplemented with morphological and floral developmental data. *Phytotaxa* 166: 1–32.
- Brockman, G. & French, C. (2021). *Pterostylis occulta* (Orchidaceae), a new species from the south-west of Western Australia. *Nytsia* 32: 51–54.
- Brown, A.P. & Phillips, R.D. (2021). *Caladenia multiplex* (Orchidaceae), a new, sexually deceptive species from the south-west of Western Australia. *Nytsia* 32: 55–58.
- Brundrett, M.C. & Hammer, T.A. (2020). The *Eriochilus dilatatus* (Orchidaceae) complex in Western Australia: subspecies taxonomy is not supported by consistent differences in morphology or distribution. *Australian Systematic Botany* 33: 329–345.
- Buirchell, B.J. & Brown, A.P. (2021). *Eremophila rarissima* (Scrophulariaceae), a new rarity from Western Australia. *Nytsia* 32: 63–66.
- Butcher, R. (2021a). Two new, orange-flowered *Tephrosia* (Fabaceae: Millettieae) species from the Kimberley region, in Western Australia's monsoon tropics. *Nytsia* 32: 39–50.
- Butcher, R. (2021b). *Tephrosia sabulosa* (Fabaceae: Millettieae), a new species from Australia's sandhill deserts. *Nytsia* 32: 109–119.
- Butcher, R. & Cowie, I.D. (2021). Redefinition of *Tephrosia supina* (Fabaceae: Millettieae), a north-west Western Australian endemic, and description of two similar species. *Nytsia* 32: 67–83.
- Butler, R.M. & Trudgen, M.E. (2021). *Eulalia simonii* R.M. Butler & Trudgen (Poaceae: Andropogoneae), a new species from the Pilbara and Gascoyne bioregions of Western Australia. *Austrobaileya* 11: 45–55.
- CHAH (Council of Heads of Australasian Herbaria) (2005a). *National Species List*. <https://id.biodiversity.org.au/instance/apni/628552> [accessed 16 November 2021].
- CHAH (Council of Heads of Australasian Herbaria) (2005b). *National Species List*. <https://id.biodiversity.org.au/instance/apni/598372> [accessed 23 February 2021].
- CHAH (Council of Heads of Australasian Herbaria) (2007). *National Species List*. <http://id.biodiversity.org.au/instance/apni/646041> [accessed 19 October 2021].
- CHAH (Council of Heads of Australasian Herbaria) (2016). *National Species List*. <https://id.biodiversity.org.au/instance/apni/7525912> [accessed 23 February 2021].
- CHAH (Council of Heads of Australasian Herbaria) (2018a). *National Species List*. <https://id.biodiversity.org.au/instance/apni/51401222> [accessed 27 July 2021].
- CHAH (Council of Heads of Australasian Herbaria) (2018b). *National Species List*. <https://id.biodiversity.org.au/instance/apni/51402473> [accessed 27 July 2021].
- CHAH (Council of Heads of Australasian Herbaria) (2021a). *National Species List*. <https://biodiversity.org.au/nsi/services/apc-format/display/9868079> [accessed 19 October 2021].
- CHAH (Council of Heads of Australasian Herbaria) (2021b). *National Species List*. <http://id.biodiversity.org.au/instance/apni/51442527> [accessed 19 October 2021].
- CHAH (Council of Heads of Australasian Herbaria) (2021c). *National Species List*. <http://id.biodiversity.org.au/instance/apni/51439771> [accessed 19 October 2021].
- CHAH (Council of Heads of Australasian Herbaria) (2021d). *National Species List*. <http://id.biodiversity.org.au/instance/apni/51440356> [accessed 19 October 2021].
- CHAH (Council of Heads of Australasian Herbaria) (2021e). *National Species List*. <https://id.biodiversity.org.au/name/apni/86039> [accessed 19 October 2021].
- Chase, M.W. & Christenhusz, M.J.M. (2021a). *Nicotiana rosulata*, Solanaceae. *Curtis's Botanical Magazine* 38: 319–328.
- Chase, M.W. & Christenhusz, M.J.M. (2021b). *Nicotiana insecticida*, Solanaceae. *Curtis's Botanical Magazine* 38: 350–364.
- Chase, M.W. & Christenhusz, M.J.M. (2021c). *Nicotiana pila*, Solanaceae. *Curtis's Botanical Magazine* 38: 394–404.
- Chase, M.W. & Christenhusz, M.J.M. (2021d). *Nicotiana hesperis*, Solanaceae. *Curtis's Botanical Magazine* 38: 405–415.
- Chase, M.W., Christenhusz, M.J.M., Palsson, R.L., Fay, M.F., Dodsworth, S., Conran, J.G., Cauz-Santos, L.A., Noll, F., Samuel, R. & Paun, O. (2021a). Species delimitation in *Nicotiana* sect. *Suaevolentes* (Solanaceae): reciprocal illumination leads to recognition of many new species. *Curtis's Botanical Magazine* 39: 266–286.
- Chase, M.W., Dodsworth, S. & Christenhusz, M.J.M. (2021b). *Nicotiana ingulba*, Solanaceae. *Curtis's Botanical Magazine* 38: 309–318.

- Chase, M.W., Fay, M.F. & Christenhusz, M.J.M. (2021c). *Nicotiana salina*, Solanaceae. *Curtis's Botanical Magazine* 39: 416–424.
- Chase, M.W., Przeslawski, R.A., Falvey, L.E., Fay, M.F. & Christenhusz, M.J.M. (2021d). *Nicotiana munchisonica*, Solanaceae. *Curtis's Botanical Magazine* 38: 383–393.
- Daniel, T.F. & McDade, L.A. (2014). Nelsonioideae (Lamiales: Acanthaceae): Revision of genera and catalog of species. *Aliso* 32: 1–45.
- Davis, R.W. & Hammer, T.A. (2020). A key to the species of *Swainsona* (Fabaceae) in Western Australia and description of *S. katjarra* from the Little Sandy Desert region, Western Australia. *Swainsona* 33: 143–148.
- Davis, R.W., Palmer, J. & Hammer, T.A. (2021). *Gomphrena axillaris* and *G. longistyla* (Amaranthaceae), new species of *Gomphrena* from central and northern Australia. *Swainsona* 35: 59–64.
- Davis, R.W. & Wege, J.A. (2021). *Isotropis petrensis* (Fabaceae: Mirbelieae), a new species from arid Western Australia. *Nuytsia* 32: 99–102.
- Del Guacchio, E., Cennamo, P. & Caputo, P. (2018). The Linnaean names in *Scabiosa* (Caprifoliaceae: Dipsacaceae). *Taxon* 67: 422–436.
- Deshmukh, U.B. (2021). *Scholtzia kalbarri*, a replacing name for *Scholtzia denticulata* (Myrtaceae: Chamelaucaceae). *Phytotaxa* 501: 300.
- Duretto, M.F., Heslewood, M.M. & Bayly, M.J. (2020). *Boronia* (Rutaceae) is polyphyletic: Reinstating *Cyanothamnus* and the problems associated with inappropriately defined outgroups. *Taxon* 69: 481–499.
- Fomichev, C.I., Macfarlane, T.D., Valiejo-Roman, C.M., Samigullin, T.H., Degtjareva, G.V., Briggs, B.G. & Sokoloff, D.D. (2021). Two centuries from species discovery to diagnostic characters: molecular and morphological evidence for narrower species limits in the widespread SW Australian *Anarthria gracilis* complex (Restionaceae s.l./Anarthriaceae, Poales). *PeerJ - Life and Environment* 9:e10935: <https://doi.org/10.7717/peerj.10935>.
- Forster, P.I. (2021). *Gymnema* R.Br. and *Leichhardtia* R.Br. (Apocynaceae), reinstated genera for taxa previously included in *Marsdenia* R.Br.: a conspectus for Australia, New Guinea and the Solomon Islands. *Austrobaileya* 11: 1–18.
- Fowler, R.M., Murphy, D.J., McLay, T.G.B., Buirchell, B.J., Chinnock, R.J. & Bayly, M.J. (2021). Molecular phylogeny of tribe Myoporeae (Scrophulariaceae) using nuclear ribosomal DNA: Generic relationships and evidence for major clades. *Taxon* 70: 570–588.
- Freire, S.E., Grossi, M.A., Iharlegui, L., Abarca, C.L., Monti, C. & Bayón, N.D. (2021). Taxonomic Identity of *Gamochoeta americana* and *Gamochoeta coarctata* (Gnaphalieae, Asteraceae). *Phytotaxa* 523: 273–283.
- Germplasm Resources Information Network (GRIN Taxonomy) (2021). *USDA, Agricultural Research Service, National Plant Germplasm System*. National Germplasm Resources Laboratory, Beltsville, Maryland. <https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomydetail?id=15321> [accessed 08 March 2021].
- Hammer, T.A. & Davis, R.W. (2021). *Ptilotus crinitus* (Amaranthaceae), a new species from Western Australia's Kimberley region. *Swainsona* 35: 55–58.
- Hislop, M. (2021). *Styphelia undulata* (Ericaceae: Epacridoideae: Styphelieae), a distinctive, short-range endemic from the Geraldton Sandplains. *Nuytsia* 32: 103–107.
- Jeanes, J.A. (2021). Studies in *Podolepis* and some related genera (Asteraceae: Gnaphalieae). *Muelleria* 39: 79–112.
- Jobson, R.W., Baleeiro, P.C. & Barrett, M.D. (2018). Six new species of *Utricularia* (Lentibulariaceae) from Northern Australia. *Telopea* 21: 57–77.
- Keighery, G.J. (2021). *Lycopus europeus* L. (Lamiaceae), a new weed record for Australia. *Western Australian Naturalist* 32: 48–50.
- Keighery, G.J. & Keighery, B. (2021). Opening Pandora's box: *Pandorea* (Bignoniaceae) in Western Australia. *Western Australian Naturalist* 32: 104–108.
- Klak, C., Bruyns, P.V. & Hedderson, T.A.J. (2007). A phylogeny and new classification for Mesembryanthemoideae (Aizoaceae). *Taxon* 56: 737–756.
- Köhler, M. & Font, F. (2021). *Opuntia leoglossa* sp. nov. (Cactaceae): a new identity for the aloctone “Lion's Tongue” cactus. *Phytotaxa* 510: 281–287.
- Krueger, T. & Fleischmann, A. (2021). A new species of *Drosera* section *Arachnopus* (Droseraceae) from the western Kimberley, Australia, and amendments to the range and circumscription of *Drosera finlaysoniana*. *Phytotaxa* 501: 56–84.
- Larridon, I., Zuntini, A.R., Barrett, R.L., Wilson, K.L., Bruhl, J.J., Goetghebeur, P., Baker, W.J., Brewer, G.E., Epitawalage, N., Fairlie, I., Forest, F., Sabino Kikuchi, I.A.B., Pokorny, L., Semmouri, I., Spalink, D., Simpson, D.A., Muasya, A.M. & Roalson, E.H. (2021). Resolving generic limits in Cyperaceae tribe Abildgaardieae using targeted sequencing. *Botanical Journal of the Linnean Society* 196: 163–187.
- Manning, J.C., Forest, F., Devey, D.S., Fay, M.F. & Goldblatt, P. (2009). A molecular phylogeny and a revised classification of Ornithogaloideae (Hyacinthaceae) based on an analysis of four plastid DNA regions. *Taxon* 58: 77–107.
- Maslin, B.R. & van Leeuwen, S. (2008). New taxa of *Acacia* (Leguminosae: Mimosoideae) and notes on other species from the Pilbara and adjacent desert regions of Western Australia. *Nuytsia* 18: 139–188.

- Moody, M.L. & Garcia, M. (2021). Post-Oligocene diversification in Australia: phylogeography, systematics and new species of *Gonocarpus* (Haloragaceae). *Taxon* 70: 761–777.
- Ohashi, H. & Ohashi, K. (2018). *Grona*, a genus separated from *Desmodium* (Leguminosae Tribe Desmodieae). *Journal of Japanese Botany* 93: 104–120.
- Ohashi, K., Ohashi, H., Nemoto, T., Ikeda, T., Izuma, H., Kobayashi, H., Muragaki, H., Nata, K., Sato, N. & Suzuki, M. (2018). Phylogenetic analyses for a new classification of the *Desmodium* group of Leguminosae Tribe Desmodieae. *Journal of Japanese Botany* 93: 165–189.
- Olde, P.M. (2020). *Grevillea pieroniae* Olde (Proteaceae: Grevilleoideae: Hakeinae), a rare new species in the Triloba Group from the Stirling Range, Western Australia, and a short history of the group. *Telopea* 23: 227–235.
- Olde, P.M. (2021a). *Grevillea hortiorum* Olde (Proteaceae: Grevilleoideae: Hakeinae), an uncommon species from winter-damp woodlands in the Avon Wheatbelt, south-west Western Australia. *Telopea* 24: 1–6.
- Olde, P.M. (2021b). *Grevillea trichantha* Olde, a third species with hairy flowers in the Triloba Group (Proteaceae: Grevilleoideae: Hakeinae) from the Marchagee Track, south-west Western Australia. *Telopea* 24: 303–309.
- Olde, P.M. (2021c). Missing in the Shark Bay area, *Grevillea speckiana* Olde, a new species and the northern-most member of the Triloba Group (Proteaceae: Grevilleoideae: Hakeinae). *Telopea* 24: 377–382.
- Olde, P.M. & Marriott, N.R. (2021). *Grevillea merceri* Olde & Marriott (Proteaceae: Grevilleoideae: Hakeinae) an uncommon, geographically isolated species in the Triloba Group from subcoastal areas of southern Western Australia. *Telopea* 24: 241–245.
- Orthia, L.A., de Kok, R.P.J. & Crisp, M.D. (2005). A revision of *Pultenaea* (Fabaceae: Mirbelieae). 4. Species occurring in Western Australia. *Australian Systematic Botany* 18: 149–206.
- Papassotiropoulos, S.E., Jacobs, S.W.L. & Hellquist, C.B. (2011). *Potamogetonaceae*. In: Wilson, A.J.G. (ed.) *Flora of Australia* 39: Alismatales to Arales. pp. 84–95. (Australian Biological Resources Study: Canberra / CSIRO Publishing: Melbourne.)
- Peterson, P.M., Romaschenko, K., Soreng, R.J. & Reyna J.V. (2019). A key to the North American genera of Stipeae (Poaceae, Pooideae) with descriptions and taxonomic names for species of *Eriocoma*, *Neotrinia*, *Oloptum*, and five new genera: *Barkworthia*, *Eriosella*, *Pseudoeriacoma*, *Psilagrostiella*, and *Thorneochloa*. *PhytoKeys* 126: 89–125.
- Rye, B.L. & Trudgen, M.E. (1998). A taxonomic revision of *Dicrastylis* sect. *Dicrastylis* (Lamiaceae subfamily Chloanthoideae). *Nuytsia* 12: 207–228.
- Sharr, F.A. & George, A.S. (2019). *Western Australian Plant Names and their Meanings* Edn 3. (Four Gables Press, Kardinya, Western Australia.)
- Shepherd, K.A. & Wilkins, C.F. (2021). A revision of *Lasiopetalum* (Malvaceae: Byttnerioideae) from the northern sandplains of Western Australia, including two new species. *Nuytsia* 32: 121–149.
- Simon, B.K. (2010). New taxa, nomenclatural changes and notes on Australian grasses in the tribe Paniceae (Poaceae: Panicoideae). *Austrobaileya* 8: 187–219.
- Smith, M.G. & Jones, A. (2018). *Threatened and Priority Flora list 5 December 2018*. Department of Biodiversity, Conservation and Attractions. <https://www.dpaw.wa.gov.au/plants-and-animal/threatened-species-and-communities/threatened-plants> [accessed 24 January 2022].
- Sukhorukov, A.P., Sennikov, A., Veranso-Libalah, M.C., Kushunina, M., Nilova, M.V., Heath, R., Heath, A., Mazei, Y. & Zaika, M.A. (2021). Evolutionary relationships, biogeography and morphological characters of *Glinus* (Molluginaceae), with special emphasis on the genus composition in Sub-Saharan Africa. *PhytoKeys* 173: 1–92.
- Thompson, E.J., Forster, P.I. (2021). *Cymbopogon procerus* (R.Br.) Domin, the correct name for *Schizachyrium mitchelliana* B.K.Simon (Poaceae: Andropogoneae), and lectotypification of *Andropogon exaltatus* R.Br. *Austrobaileya* 11: 41–44.
- Turner, I.M. (2018). Annonaceae of the Asia-Pacific region: names, types and distributions. *The Gardens' Bulletin, Singapore* 70: 409–744.
- Wilde, B.C. & Barrett, R.L. (2021). Hiding in plain sight, *Ficus desertorum* (Moraceae), a new species of rock fig for Central Australia. *Telopea* 24: 283–301.
- Wilson, K.L. (2015). Two new species and three new combinations in Cyperaceae of New Caledonia and Australia. *Telopea* 18: 127–134.
- Wilson, Peter G. (2021). Progress towards resolution of the *Indigofera monophylla* complex (Fabaceae: Faboideae). *Telopea* 24: 311–317.
- Wilson, T.C., Radunz, E.A., Chen, S.H., Conn, B.J. & Henwood, M.J. (2021). A new genus and species for Chloanthaceae (Lamiaceae). *Australian Systematic Botany* 34: 485–509.
- Yu, R.-Y., Slik, F.J.W. & Welzen, P.C. van (2019). Molecular phylogeny of *Trigonostemon* and its relatives (Euphorbiaceae). *Taxon* 68: 918–936.

***Stylidium milleri* (Stylidiaceae), a striking discovery from south-western Australia**

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SHORT COMMUNICATION

The novel species of *Stylidium* Sw. ex Willd. (Stylidiaceae) described below was unearthed at the Western Australian Herbarium (PERTH) while sorting specimens and compiling information for an account of Stylidiaceae for the *Flora of Australia*. It was recently relocated in the wild, at which time the first collections for more than 30 years were made. It is remarkable that such a large-flowered and attractive triggerplant has remained unrecognised until now and suggests that botanical surveys of remnant vegetation on the Dandaragan Plateau may yield additional botanical treasures.

Stylidium milleri* Wege, *sp. nov.

Type: south-west of Moora, Western Australia [precise locality withheld for conservation reasons], 3 October 2021, J.A. Wege 2137 (*holo:* PERTH 09389091; *iso:* AD, CANB, MEL, NSW).

Stilted perennial herb (10–)20–40 cm high. *Indumentum* of glandular hairs 0.2–0.6(–1) mm long with a red or red-black, ellipsoid head and simple, \pm straight or sinuate hairs 0.8–4 mm long. *Stem* contracted or shortly elongated, unbranched or branched, glabrous, nodes clothed with persistent leaf bases; stilt roots papillose. *Leaves* basal, those of the present season's growth subtended by papery scale leaves, linear, (60–)120–350 mm long, 0.5–1.3 mm wide, glabrous or with fibrous papillae abaxially (especially towards the base), apex with a fibrous mucro 0.2–0.3 mm long; margins involute, stomata confined to either side of midrib on adaxial surface. *Scapes* 1–6 per plant, (9–)15–37 cm long including inflorescence, 0.9–2.3 mm wide, with simple hairs below inflorescence (denser in the lower portion) and glandular hairs throughout (i.e. including inflorescence axis) or absent towards base. *Inflorescence* determinate, botryoid or more rarely thyrsoïd, corymbiform, 4–10-flowered, flowers rotated 180°; primary bracts 4–8 mm long, glandular-hairy (very rarely with the odd simple hair); pedicels 5–32 mm long, glandular-hairy. *Hypanthium* ellipsoid to \pm globose, 4–7.5 mm long, 2.5–5 mm wide, glandular-hairy. *Calyx lobes* free, 4–8 mm long, glandular-hairy (sometimes including the inner surface near tip), apex acute or apiculate. *Corolla* white with pink-red markings towards base of lobes (often faint or absent from lower pair), undersurface and tube creamy yellow with dark pink-red speckled markings; lobes paired vertically, glandular-hairy abaxially and on anterior margin of anterior lobes; anterior (upper) lobes \pm oblong with a constriction below a flared and rounded apex, markedly incurved, slightly longer than the posterior pair, 9–14 mm long, 5.3–8.5 mm wide; posterior (lower) lobes basally connate for 1.5–3 mm, \pm obovate, scarcely incurved, 7–11 mm long, 4.3–8.5 mm wide;

tube 7–9 mm long, longer than the calyx lobes, glabrous except for sparse glandular hairs and dense papillae near anterior sinus. *Labellum* at sinus base, elliptic, 1–1.5 mm long with a papillose beard 0.4–1.2 mm long, sometimes with a few glandular hairs abaxially; lateral appendages 1–1.5 mm long, forward-projecting, papillose. *Throat appendages* 4 (1 on each corolla lobe), dimorphic, papillose; anterior appendages white, wing-like, 1.7–3 mm high; posterior appendages white with a dark pink-red tip, \pm oblong, distally recurved, *c.* 1.5–2.5 mm high. *Column* 12–14 mm long, straight when extended, with a strong bend below the anthers, glabrous; anther locules 1.2–1.5 mm long, corona present, pollen pale blue-green; stigma sessile, bilobed. *Capsules* ellipsoid to \pm globose, *c.* 6–10 mm long excluding calyx lobes; halves detaching distally, often also with irregular, lateral or basal splits, not recurved. *Seeds* not seen. (Figure 1)

Diagnostic features. *Stylidium milleri* can be recognised by the following key features: a stilted habit; linear leaves subtended by papery scale leaves; a mixture of simple hairs and shorter glandular hairs on the scape; a determinate, corymbiform, glandular-hairy inflorescence with pedicels 5–32 mm long; a long corolla tube (exserted beyond the calyx lobes); white corolla lobes with pink-red speckled markings on the undersurface, the upper pair with a rounded apex; 4 throat appendages (one on each corolla lobe); and a column with a conspicuous corona (i.e. prominent hairs surrounding the anthers).

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] Sep. 1946, *Miss A. Ashby* 103 (PERTH); 25 Sep. 1965, *A.S. George* 6846 (PERTH); 10 Sep. 1988, *E.A. Griffin* 4981 (PERTH); 7 Oct. 1967, *W.A. Loneragan* 67.110 (PERTH); 4 Oct. 1971, *R.D. Royce* 9524 (PERTH); 5 Oct. 1971, *R.D. Royce* 9588 (PERTH); 3 Oct. 2021, *J.A. Wege* 2133 (PERTH, MEL).

Flowering period. September–October.

Distribution and habitat. *Stylidium milleri* is endemic to south-western Australia and has a distribution centred on the Dandaragan Plateau, occurring from the Regans Ford area to Watheroo National Park. It favours upland habitats, growing in grey sand with lateritic gravel in *Allocasuarina* and *Lambertia* shrubland with *Xanthorrhoea* and scattered mallees, Proteaceous and Myrtaceous shrubland with *Allocasuarina* and scattered *Banksia attenuata*, or *B. carlinoides* heath.

Conservation status. To be listed as Priority Two under Conservation Codes for Western Australian Flora (T. Llorens pers. comm.). This species is represented by few collections from a heavily cleared landscape and appears to have specific habitat requirements. It was collected from Watheroo National Park by Bob Royce in the 1970s on two separate occasions (presumably from two different sites), and a small population was recently discovered in a nature reserve north-west of Regan's Ford. The type locality is a small, unmanaged reserve that is (or has been) subject to gravel extraction. Surveys are needed to better understand the species' distribution and abundance, and any additional threats.

Etymology. Named for Dr Ben Paul Miller (1970–) who has steadfastly supported my taxonomic research for some 20 years, frequently assisting me on collecting trips thinly disguised as holidays. Ben is a highly respected ecologist who continues to make a broad contribution to flora conservation in Western Australia, most notably through his collaborative fire science research and mentoring of students and early career researchers.

Vernacular name. Miller's Triggerplant.

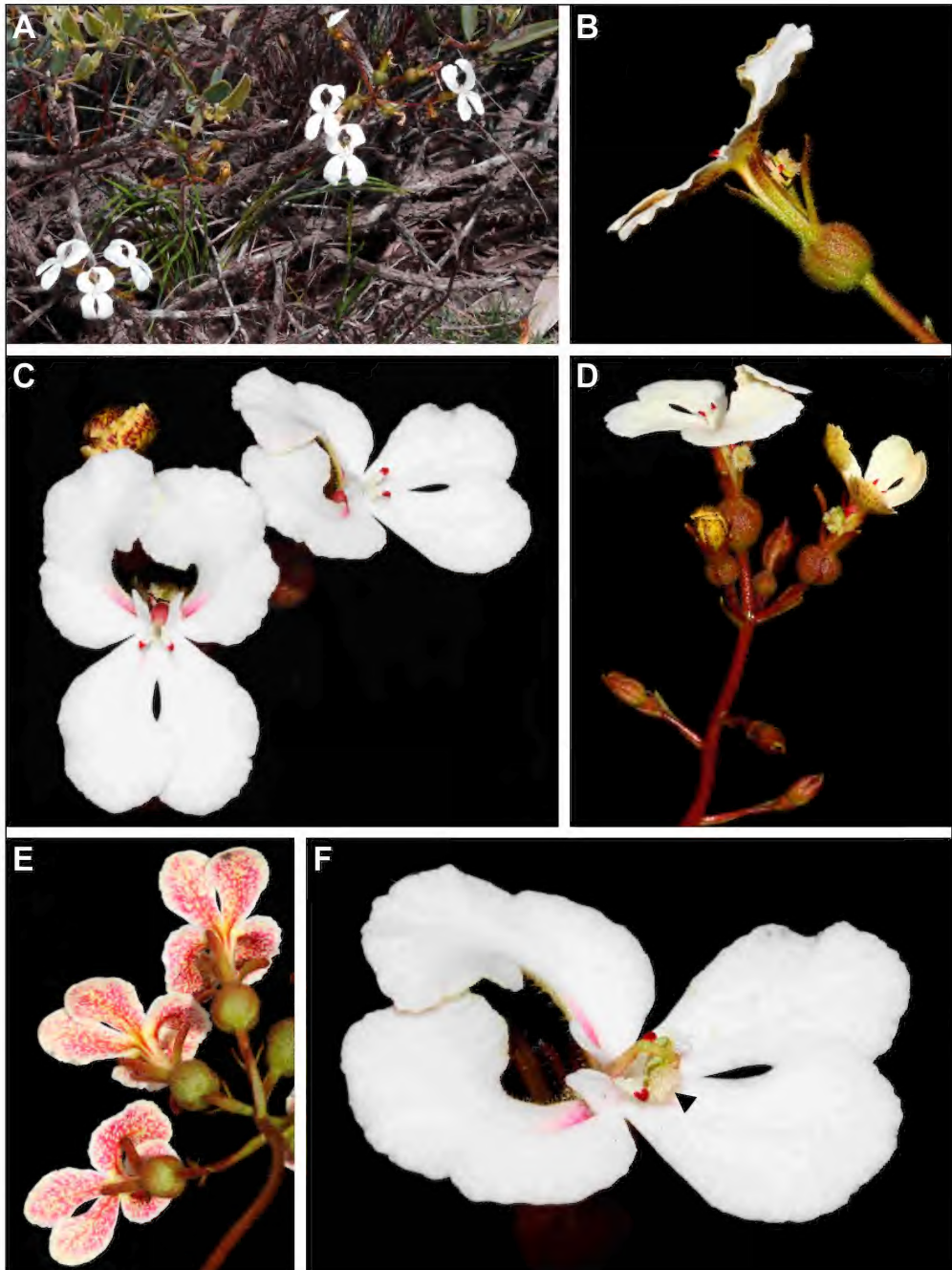


Figure 1. *Stylidium milleri*. A – habit, with plants growing under shrubs; B – side view of flower, showing the ellipsoid hypanthium, slender calyx lobes and long corolla tube; C – inflorescence, showing the distinctive shape and colouration of the corolla face and throat appendages; D – inflorescence, showing the determinate, corymbiform structure; E – distinctive patterning on the corolla undersurface; F – flower with column released, showing the conspicuous corona (black arrow). Photographs from J.A. Wege 2133 (A, D, E) and J.A. Wege 2137 (B, C, F).

Notes. *Stylidium milleri* is akin to *S. macranthum* Carlquist, a species that occurs from Munglinup to Israelite Bay on Western Australia's south coast. The two species have a comparable habit, leaf morphology, indumentum and inflorescence architecture but can be readily separated by their flowers. In *S. milleri*, the anterior (upper) corolla lobes are oblong with a constriction below a flared and rounded apex (i.e. more or less pandurate) whereas in *S. macranthum* they are lanceolate and taper to an obtuse or acute apex. The corolla face is predominantly white in *S. milleri* (cf. mauve-pink in *S. macranthum*, although a rare white form (PERTH 01206168) has been recorded from Cape Arid National Park), and there is one rather than two throat appendages on each posterior (lower) corolla lobe. The labellum of *S. milleri* also tends to have shorter lateral appendages (1–1.5 mm long cf. 1.5–3 mm long in *S. macranthum*), although relatively few measurements have been made for me to be confident of this difference.

Stylidium milleri is perhaps more likely to be confused with *S. diplotrichum* Wedge, a poorly known species from the Lesueur Sandplains with a somewhat similar corolla. Unlike *S. diplotrichum*, *S. milleri* has leaves with involute margins and stomata confined to either side of the midrib on the adaxial surface (cf. with entire margins and stomata confined to two longitudinal furrows on each surface), longer pedicels (5–32 mm long cf. 1–4 mm), and a strictly glandular-hairy indumentum on the pedicels and hypanthium (cf. with both glandular and simple hairs). *Stylidium diplotrichum* also lacks the coloured markings near the base of the upper corolla lobes and on the undersurface of the corolla that are characteristic of *S. milleri*.

Stylidium schoenoides DC. and *S. stenosepalum* E.Pritz. have both been observed growing with *S. milleri* and may cause confusion. Pressed material of *S. schoenoides* is remarkably like the new species on account of its comparable leaf morphology, indumentum and inflorescence structure, but can be diagnosed by the absence of stilt roots (i.e. the stem stock is buried rather than elevated above the substrate), shorter corolla tube (3–5 mm long cf. 7–9 mm in *S. milleri*), and unusually stout column with an inconspicuous corona and an entire (cf. bilobed) stigma that expands between and below the lower anther thecae. *Stylidium stenosepalum* has a stilted habit and large flowers like *S. milleri* but is readily differentiated by its strictly glandular-hairy scapes, racemose inflorescences (i.e. flowers open sequentially from the base to the apex), and mostly longer calyx lobes (7.4–15 mm long cf. 4–8 mm in *S. milleri*) that exceed the length of the corolla tube (cf. corolla tube longer than the calyx lobes).

Acknowledgements

This research was supported by the Australian Government's Australian Biological Resources Study National Taxonomy Research Grant Programme for the project 'Time to pull the trigger – an eFlora account of Stylidiaceae'. I thank Ben Miller for his assistance during our initial, unsuccessful hunt for this species.

***Drummondita billyacatting* (Rutaceae), a new, range-restricted species from Western Australia**

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Abstract

Shelton, L.R.J. & Thiele, K.R. *Drummondita billyacatting* (Rutaceae), a new, range-restricted species from Western Australia. *Nuytsia* 33: 19–27 (2022). The new species *Drummondita billyacatting* L.R.J.Shelton & K.R.Thiele is described for a taxon previously phrase-named as *D. sp.* Trayning (A.M. George 97), which is narrowly endemic to Billyacatting Hill in the Western Australian wheatbelt. The new species is morphologically readily separable from the widespread *D. hassellii* (F.Muell.) Paul G.Wilson and the morphologically rather similar *D. longifolia* (Paul G.Wilson) Paul G.Wilson. A key is provided to all species of *Drummondita* Harv. (Rutaceae).

Introduction

Drummondita Harv. (Rutaceae) is a small genus of shrubs, mostly endemic to the wheatbelt and adjacent semi-arid regions of south-western Western Australia. Exceptions are *D. calida* (F.Muell.) Paul G.Wilson, which occurs on southern Cape York Peninsula in Queensland, and *D. borealis* Duretto, which occurs in the Top End of the Northern Territory (Duretto, 2018). Of the Western Australian species, *D. hassellii* (F.Muell.) Paul G.Wilson is geographically and ecologically widespread in the eastern wheatbelt, while most of the remainder are more restricted. Four Western Australian species (*D. ericoides* Harv., *D. longifolia* (Paul G.Wilson) Paul G.Wilson, *D. rubriviridis* R.A.Meissn. and *D. wilsonii* Mollemans) are endemic to single peaks or range systems (Mollemans 1993; Wilson 1998; Stack *et al.* 2004; Meissner & Markey 2007).

Wilson (1971) reinstated *Drummondita* as distinct from *Philotheca* Rudge, within which it had been subsumed by Mueller (1869). Bayly (2001) supported the monophyly of *Drummondita* but not of *Philotheca* (Bayly *et al.* 2013).

This paper provides a morphometric analysis of the Western Australian phrase-named species *Drummondita sp.* Trayning (A.M. George 97) in comparison with *D. hassellii* and *D. longifolia*, and describes it as new. *Drummondita longifolia* is a former variety of the widespread *D. hassellii* (Wilson 1998), with Wilson (2013) commenting on similarity between *D. sp.* Trayning and *D. longifolia*.

Methods

Seventy specimens (51 specimens from the Western Australian Herbarium and 19 field collections) were assessed and measured for this analysis. The herbarium specimens included 39 *D. hassellii*, six *D. longifolia*, three *D. sp.* Trayning and three specimens undetermined at species rank, filed as *Drummondita sp.* A population sample of 19 flowering shoots of *D. sp.* Trayning was collected from Billyacatting Hill to augment the limited available herbarium material. These were pressed and dried to ensure that their measurements would be comparable with herbarium specimens.

Only herbarium specimens with more than three available flowers were measured (because measurement of some floral characters required dissection after rehydration). Three visually average leaves and one flower were measured from each specimen. Leaves were measured dry, while flowers were rehydrated via submergence in a beaker of boiling water with a drop of dish soap for one minute. Leaf measurements were averaged. Characters measured are given in Table 1.

Table 1. Characters measured and assessed. Characters marked with an asterisk were removed from the analysis due to auto-correlations with flower length.

| Code | Character | State | Type |
|------|--------------------------------|---|------------|
| 1 | Ciliate hairs on stems | (0) Absent; (1) sparse (mostly glabrous, with few hairs on some young branchlets); (2) frequent (mostly evenly distributed across all branches) | Multistate |
| 2 | Leaf length | Measured (in mm) from base of petiole to tip of leaf mucro | Continuous |
| 3 | Leaf width | Measured (in mm) across leaf blade at widest point | Continuous |
| 4 | Petiole length | Measured (in mm) from point of connection with stem to thickening or angling of leaf blade | Continuous |
| 5 | Orientation of leaf apex | (0) Straight; (1) inclined | Binary |
| 6 | Leaf papilla size | (0) Small ($<0.8 \text{ mm}^2$); (1) medium (approximately 0.8 mm^2); (2) large ($>0.8 \text{ mm}^2$) | Multistate |
| 7 | Leaf shape | (0) Obovate; (1) linear | Binary |
| 8 | Leaf base | (0) Cuneate; (1) obtuse | Binary |
| 9 | Cilia hairs on leaf margins | (0) Absent; (1) sparse (mostly glabrous with occasional hairs); (2) frequent (mostly evenly distributed along margin) | Multistate |
| 10 | Leaf mucro length | Measured (in mm) from translucent section of leaf apex to tip | Continuous |
| 11 | Leaf mucro pubescence | (0) Absent; (1) present | Binary |
| 12 | Leaf mucro curvature | (0) Curved; (1) not curved | Binary |
| 13 | Flower length | Measured (in mm) from base of receptacle to tip of exerted stigma | Continuous |
| 14 | Flower width | Measured (in mm) across perianth at widest point | Continuous |
| 15 | Sepal length | Measured (in mm) from insertion of sepals on the receptacle, to apex | Continuous |
| 16 | Sepal width | Measured (in mm) across sepals at widest point | Continuous |
| 17 | Ciliate hairs on sepal margins | (0) Absent; (1) sparse (mostly glabrous with occasional hairs); (2) frequent (mostly evenly distributed along margin) | Multistate |

| Code | Character | State | Type |
|------|--------------------------------|---|------------|
| 18 | Petal length* | Measured (in mm) from base to apex | Continuous |
| 19 | Petal width | Measured (in mm) across widest point | Continuous |
| 20 | Ciliate hairs on petal margins | (0) Absent; (1) sparse (mostly glabrous with occasional hairs); (2) frequent (mostly evenly distributed along margin) | Multistate |
| 21 | Stamen filament length* | Measured (in mm) from insertion of filament to base of anther | Continuous |
| 22 | Anther length | Measured (in mm) from apex of filament to apex of anther | Continuous |
| 23 | Anther width | Measured (in mm) across widest point | Continuous |
| 24 | Style length* | Measured (in mm) from point of connection with ovary to base of stigma | Continuous |
| 25 | Ciliate hairs on style | (0) Absent; (1) present | Multistate |
| 26 | Stigma length | Measured (in mm) from the point at which the stigma widens | Continuous |
| 27 | Stigma width | Measured (in mm) across widest diameter | Continuous |

Data were analysed using Primer 6.1 (Clarke & Gorley 2006). Auto-correlations between characters were assessed using Draftsman's plots, and logically related characters with correlations >0.8 were reduced to a single character. A resemblance matrix using all remaining characters was constructed using the Gower metric (Gower 1971). Samples were ordinated using non-metric Multi-Dimensional Scaling (nMDS) with 25 restarts and Kruskal fit scheme 1, and classified using the agglomerative unweighted pair group method with arithmetic mean (UPGMA). A similarity percentages breakdown (SIMPER) procedure (Clarke & Gorley 2006) was undertaken with square root transformed data to determine which variables contributed most to the dissimilarity between samples.

Results

Three characters (petal length, staminal filament length and style length) were removed from the dataset because they were highly correlated with flower length. Both the UPGMA classification and two-dimensional nMDS ordination (stress=0.13) showed clear morphological separation between *Drummondita* sp. Trayning, *D. hassellii* and *D. longifolia* (Figure 1). *Drummondita* sp. Trayning and *D. longifolia* are morphologically close, clustering at 80% similarity. The field-collected samples from Billyacatting Hill clearly clustered with the herbarium samples of *D. sp.* Trayning, adding substantial variation within that cluster. The herbarium specimens determined as *D. sp.* were clearly assignable to *D. hassellii*. A wide range of characters were correlated with the separation of the three taxa along the main axis of the ordination (Figure 1). Leaf characters contributed most to the separation of *D. hassellii* from *D. sp.* Trayning and *D. longifolia* in the classification (Table 2), while leaf length and flower size contributed most to the separation of *D. sp.* Trayning from *D. longifolia* (Table 3).

Table 2. Characters contributing to the separation of *D. hassellii* from *D. sp.* Trayning and *D. longifolia*.

| Code | Character | Contribution (%) | Cumulative contribution (%) |
|------|-----------------------------|------------------|-----------------------------|
| 2 | Leaf length | 12.93 | 12.93 |
| 9 | Cilia hairs on leaf margins | 10.04 | 22.97 |
| 5 | Orientation of leaf apex | 9.25 | 32.22 |
| 11 | Leaf mucro pubescence | 7.11 | 39.33 |

| Code | Character | Contribution (%) | Cumulative contribution (%) |
|------|------------------------|------------------|-----------------------------|
| 12 | Leaf mucro curvature | 6.58 | 45.91 |
| 1 | Ciliate hairs on stems | 6.32 | 52.23 |

Table 3. Characters contributing to the separation of *D. sp.* Trayning and *D. longifolia*.

| Code | Character | Contribution (%) | Cumulative contribution (%) |
|------|----------------------|------------------|-----------------------------|
| 2 | Leaf length | 15.19 | 15.19 |
| 13 | Flower length | 9.87 | 25.06 |
| 16 | Sepal width | 9.38 | 34.44 |
| 12 | Leaf mucro curvature | 8.75 | 43.19 |
| 15 | Sepal length | 8.45 | 51.64 |

Some morphological variation is evident within the widespread *D. hassellii*, with four groups discernible at the 80% similarity level in the nMDS classification (Figure 1), one comprising the single specimen PERTH 00960683 (*J. Dodd* 225) from the eastern end of Lake Deborah West, one comprising the two specimens PERTH 00958034 and PERTH 06015298 (*N.N. Donner* 4592 and *S. Donaldson & G. Flowers* SD 1353 respectively) from near Merredin and west of Bullfinch, one comprising the three specimens PERTH 08420009, PERTH 05399378 and PERTH 00958077 (*G. Brockman* GGB 2485, *J. Buegge* E 26 and *C.A. Gardner* 2763 respectively) from south of Forrestania, between Bruce Rock and Cramphorne, and near Campion, and the last comprising all remaining samples. None of these groups is geographically, ecologically or morphologically consistent. The analysis recovered no discernible pattern within *D. hassellii* that would indicate that it should be split into further taxa.

Discussion

The morphometric analysis indicated that *Drummondita sp.* Trayning is distinct from, and morphologically intermediate between, *D. hassellii* and *D. longifolia*, with both analyses placing it closer to the latter than the former. *Drummondita longifolia* is endemic on Peak Charles, while *D. sp.* Trayning is endemic on Billyacatting Hill; the distance between these is *c.* 360 km, with *D. hassellii* common and widespread in the areas between.

In addition to the characters measured for the analysis, *Drummondita sp.* Trayning has a distinctive bark, leaf colour, and pattern of scars on the stems (see key and Taxonomy section below). These characters were not included in the morphometric analysis as they are difficult to quantify, but they remain useful for delineating *D. sp.* Trayning. Given its distinctiveness and ready separation from both *D. hassellii* and *D. longifolia*, we recognise *D. sp.* Trayning as a distinct species, described here as *D. billyacatting* L.R.J.Shelton & K.R.Thiele.

The formal recognition of *D. billyacatting* adds a further species in the genus that is endemic to a single hill, outcrop or range. A well-resolved and species-complete phylogeny and biogeographic analysis of *Drummondita* is currently lacking. The genus may be an example of progressive speciation of narrowly endemic specialised taxa from a widespread and ecologically rather generalised taxon (*D. hassellii*). The relationships between the two northern Australian species, *D. calida* and *D. borealis*, and the Western Australian species may provide useful insights into the biogeographic history of Australia.

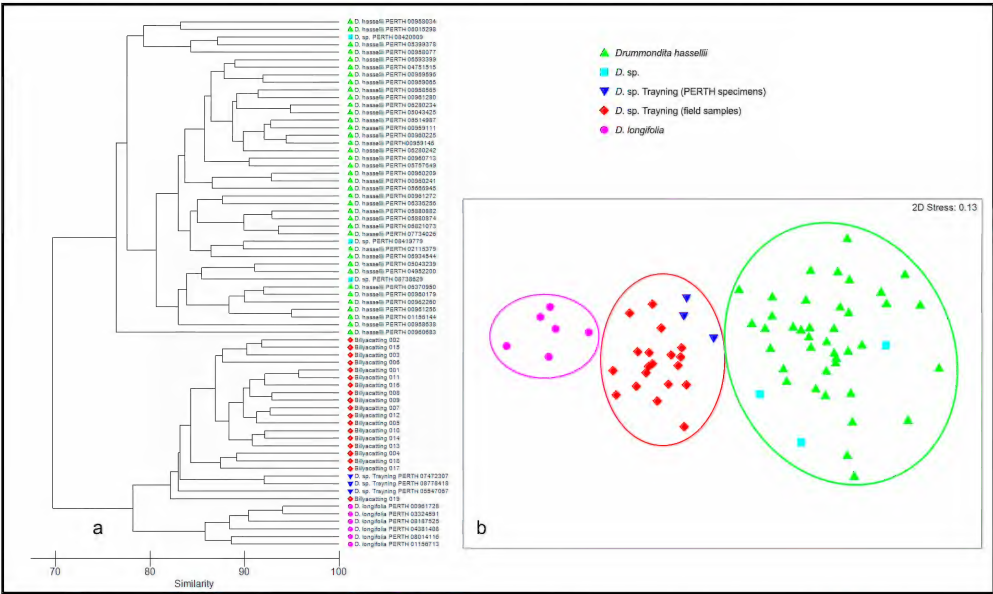


Figure 1. UPGMA classification (left) and nMDS ordination (right) of samples of *Drummondita hassellii* (▲), *D. sp.* Trayning (PERTH specimens ▼; field samples ◆), *D. longifolia* (●) and three undetermined specimens at PERTH (*D. sp.*) (■).

Key to species of *Drummondita*

(Modified from Wilson 2013)

1. Fully developed leaves > 14 mm long (rarely down to 8.5 mm), acuminate or the apex rounded with a short mucro.
 2. Flowers pedicellate ***D. borealis***
 - 2: Flowers sessile.
 3. Sepals 4.5–6 mm long ***D. billyacatting***
 - 3: Sepals: 6–9 mm long.
 4. Branchlets with sparse translucent cilia, without dark stipular excrescences; Western Australia ***D. longifolia***
 - 4: Branchlets with or without translucent cilia, with dark stipular excrescences; Queensland ***D. calida***
- 1: Fully developed leaves < 12 mm long or if longer then with a rounded apex lacking a mucro (Western Australia)
 5. Leaves 10–15 mm long with rounded apex; sepals minutely tomentose ***D. miniata***
 - 5: Leaves to 12 mm long; sepals glabrous or ciliate (rarely hispidulous in *D. hassellii*)
 6. Branchlets initially appressed-puberulous; sepals glandular-verrucose.
 7. Leaves ascending ***D. ericoides***
 - 7: Leaves spreading ***D. rubriviridis***
 - 6: Branchlets glabrous or sparsely puberulous; sepals not or scarcely glandular-verrucose.

- 8. Flowers in terminal clusters of 1–3, shortly pedicellate **D. wilsonii**
- 8: Flowers solitary, sessile or shortly pedicellate.
- 9. Leaves sessile; sepals with raised fleshy ridge in centre **D. microphylla**
- 9: Leaves with a short (c. 0.4 mm) erect petiole; sepals various.
- 10. Leaves 3–12 mm long, apiculate **D. hassellii**
- 10: Leaves 2–3.2 (–3.6) mm long, minutely apiculate **D. fulva**

Taxonomy

Drummondita billyacatting L.R.J.Shelton & K.R.Thiele, *sp. nov.*

Type: Billyacatting Hill, NE of Kununoppin, Western Australia [precise locality withheld for conservation reasons], 2 September 1976, *A.M. George* 97 (*holo:* PERTH 05547067).

Drummondita sp. Trayning (A.M. George 97) Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 27 March 2021].

Shrubs to 70 cm high. *Branchlets* erect, cream-coloured when young, verrucose and sparsely puberulous, resinous (particularly in leaf axils of young growth and especially those of leaves subtending flowers). *Leaves* shortly petiolate, alternate, scattered becoming crowded at tips of stems, linear, (8.5–) 14.5–20 mm long, 0.6–1.9 mm wide, papillate with pronounced oil glands, glabrous or sometimes sparsely puberulous near tip or margin; apex with a short, usually curved and often pubescent mucro 0.2–0.8 mm long; base cuneate, stipular excrescences absent. *Bracteoles* absent. *Flowers* 1–3 per branch at apex, sessile, 13–21.2 mm long, c. 4–5.5 mm wide. *Sepals* broadly elliptic, 4.5–6 mm long, c. 2.5–4.2 mm wide, coriaceous, resinous, yellow and/or green sometimes with red tips, glabrous except for marginal cilia. *Petals* constricted below middle, oblong, c. 11.4–14.5 mm long, 2.5–4 mm wide, yellow below, dark red towards apex, with scattered oil glands, glabrous except for marginal cilia (especially prevalent at apex). *Stamens* 5, exceeding the petals, alternating with 5 staminodes; *filaments* united for $\frac{3}{4}$ of length, with the free portion dark red, c. 11.5–19 mm long, pilose-sericeous (densely so towards the apex and with a very dense ring of hairs present just above the line of the ovary on the inside); *anthers* dorsifixed, apiculate, included within filaments, 2.5–4 mm long. *Ovary* of 5 free carpels, subglobose, c. 1.3–1.5 mm high, 1.8–2 mm wide, glabrous; *style* slender, c. 12–18 mm long, glabrous; *stigma* exerted, c. 0.3–0.7 mm long, 0.5–1 mm wide, subglobose-disciform. *Seeds* glossy, dark brown, reniform, with a cream-coloured aril. (Figure 2)

Diagnostic features. *Drummondita billyacatting* may be distinguished from all other members of the genus by the combination of pale cream-coloured bark, light yellowish-green leaves with translucent mucronate apices, and yellow flowers (the petals sometimes red-tipped).

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 13 Jun. 2006 *W. Johnston* WJ 17 (PERTH); 31 Aug. 2014 *K.R. Thiele* 5087 (PERTH).

Phenology. Flowers in August and September

Distribution and habitat. Known only from Billyacatting Hill, which is c. 16 km NE of Kununoppin and 417 m above sea level (Figure 3) (Chapman 1981). Billyacatting Hill Nature Reserve comprises



Figure 2. *Drummondita billyacatting* (left; K.R. Thiele 5807) and *D. hassellii* (right; K.R. Thiele 4487).

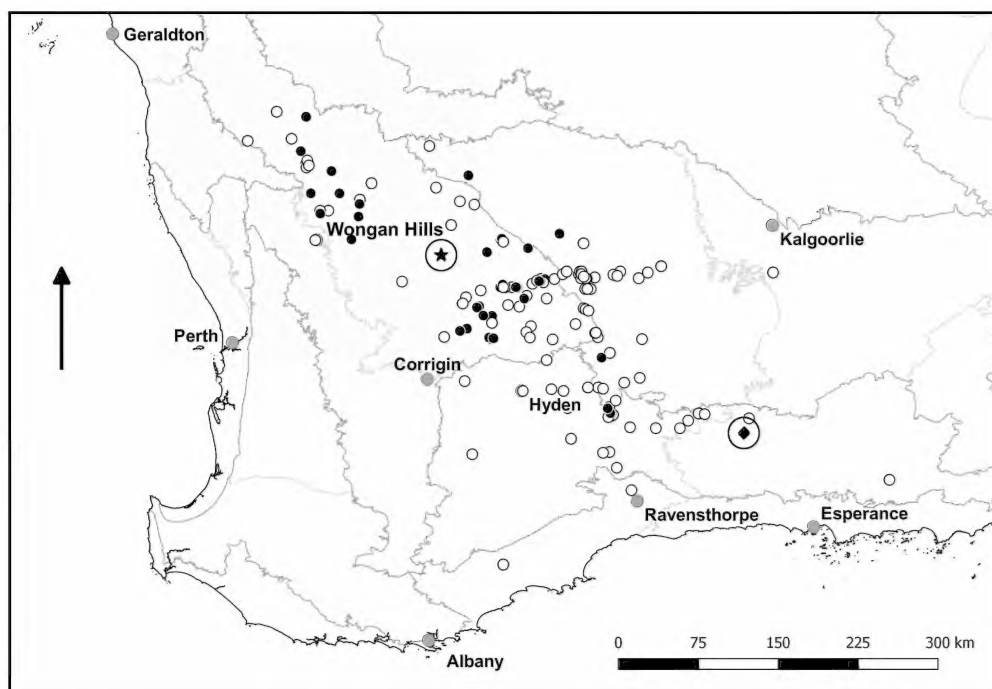


Figure 3. Distribution of *Drummondita billyacatting* (★, circled), *D. longifolia* (◆, circled) and *D. hassellii* (● specimens used in the analysis, ○ other specimens).

2075 ha., with approx. 66% being outcropping granite (Chapman 1981). The vegetation is dominated by species of *Melaleuca*, *Acacia*, *Allocasuarina*, *Eucalyptus*, *Dodonaea*, *Lepidosperma*, *Calothamnus* and *Borya* (Muir 1981). *Drummondita billyacatting* grows in cracks and patches of shallow soil within lithic vegetation complexes below the main peak; given the amount of outcropping granite in the reserve it may be locally more widespread than collections indicate.

Conservation status. Listed as Priority Two under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *D. sp.* Trayning (A.M. George 97).

Etymology. The epithet is derived from the name Billyacatting and is used as a noun in apposition. ‘Billyacatting’ in turn is an indigenous place name in the Noongar language, possibly derived from *bilya* or *beliar* (water or river), *kat* (hill) and *-ing* (place of).

Notes. *Drummondita billyacatting* is most similar to *D. longifolia* (a threatened species known only from Peak Charles), but has smaller flowers and shorter leaves, both intermediate between those of *D. longifolia* and *D. hassellii*. Frequency of mucro curvature is also intermediate with *D. longifolia* (mostly curved mucros) and *D. hassellii* (mostly straight mucros). It differs from *D. hassellii* most noticeably in having pale yellowish green and widely spaced leaves (dark green and crowded in *D. hassellii*), and cream-coloured bark on young branchlets (bark grey to brown in *D. hassellii*). Petals of plants at Billyacatting Hill vary from all-yellow to yellow with red tips of varying length; in all other respects plants with these two flower colours are identical, and the colours are scattered in the population. Red-tipped petals have been observed on young and old flowers and are therefore not the product of senescence.

Acknowledgements

This research was conducted on Wadjuk and Ballardong country and we acknowledge the first nations people of Western Australia, who are the traditional custodians of places such as Billyacatting Hill. We thank the Curator and staff of the Western Australian Herbarium for use of their collection and facilities, particularly Juliet Wege, Karina Knight, Shelley James and Rob Davis. Juliet Wege made an early morphological assessment of *Drummondita sp.* Trayning and her notes were invaluable.

References

- Bayly, M.J. (2001). A cladistic and biogeographic analysis of *Philotheca* (Rutaceae) and allied genera. PhD thesis, School of Botany, The University of Melbourne.
- Bayly, M.J., Holmes, G.D., Forster, P.I., Cantrill, D.J. & Ladiges, P.Y. (2013). Major clades of Australasian Rutoideae (Rutaceae) based on rbcL and atpB sequences. PLoS ONE 8(8): e72493. <https://doi.org/10.1371/journal.pone.0072493>
- Chapman, A. (1981). Introduction to Billyacatting Hill Nature Reserve. In: Biological survey of the Western Australian wheatbelt. Part 13, Billyacatting Hill Nature Reserve. *Records of the Western Australian Museum*, supplement 13: 9–12.
- Clarke, K.R. & Gorley, R.N. (2006). PRIMER v6: User Manual/Tutorial. (PRIMER-E: Plymouth.)
- Duretto, M.F. (2018). *Drummondita borealis* Duretto (Rutaceae), a new species from the Northern Territory, and a revised description for *D. calida* (F.Muell.) Paul G. Wilson from Queensland. *Austrobaileya* 10(2): 236–241.
- Gower, J.C. (1971). A general coefficient of similarity and some of its properties. *Biometrics*: 27(4): 857–871.
- Meissner, R.A. & Markey, A.S. (2007). Two new Western Australian species of *Drummondita* (Rutaceae: Boroniceae) from banded ironstone ranges of the Yilgarn Craton. *Nytsia* 17: 273–280.
- Mollemans, F.H. (1993). *Drummondita wilsonii*, *Philotheca langei* and *P. basistyla* (Rutaceae), new species from south-west Western Australia. *Nytsia* 9(1): 95–109.
- Muir, B.G. (1981). Vegetation of Billyacatting Hill Nature Reserve. In: Biological survey of the Western Australian wheatbelt. Part 13, Billyacatting Hill Nature Reserve. *Records of the Western Australian Museum*, supplement 13: 13–29.

- Stack, G., Chant, A. & English, V. (2004). Interim Recovery Plan no. 168 Moresby Range *Drummondita* (*Drummondita* *ericoides*) Interim Recovery Plan 2004–2009, Department of Conservation and Land Management, Western Australian Threatened Species and Communities Unit (WATSCU).
- Western Australian Herbarium (1998–). *Florabase—the Western Australian Flora*. Department of Biodiversity, Conservation and Attractions. <https://florabase.dpaw.wa.gov.au/> [accessed 24 January 2022].
- Wilson, P.G. (1971). Taxonomic notes on the family Rutaceae, principally of Western Australia. *Nuytsia* 1(2): 197–207.
- Wilson, P.G. (1998). Nomenclatural notes and new taxa in the genera *Asterolasia*, *Drummondita* and *Microcybe* (Rutaceae: Boronieae). *Nuytsia* 12(1): 83–88.
- Wilson, P.G. (2013). *Drummondita* (Rutaceae). In: Wilson, A.J.G. (ed.) *Flora of Australia* 26: 427–431. (Australian Biological Resources Study: Canberra / CSIRO Publishing: Melbourne.)

The Button Mangrove *Conocarpus erectus* (Combretaceae) is naturalised in Western Australia

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SHORT COMMUNICATION

Conocarpus L. (Combretaceae) comprises two species of tall shrubs to small trees. *Conocarpus lancifolius* Engelm. is native to and restricted to seasonal rivers and coastal sites around the Red Sea from Somalia to Yemen, and coastal riverine sites in southern Asia (Thulin 1993). *Conocarpus erectus* L. is native to coastal sites in southern Florida, Bermuda, the Bahamas, the West Indies and Mexico, as well as the Atlantic coast of Brazil, the Pacific coast from Mexico to Peru including the Galapagos Islands, and the west coast of Africa from Senegal to the Democratic Republic of the Congo (Barwick 2004). Both species are widely planted throughout the Middle East, Africa and south-west Asia.

Conocarpus erectus (Button Mangrove or Button Wood) is a dense, multi-trunked shrub or tree to 20 m high that normally grows in brackish water and tidal lagoons but is sometimes found in inland riverine areas in Central America. It has two currently recognised named forms, the Green Buttonwood (var. *erectus*), which has hairless to sparsely hairy leaves, and the Silver Buttonwood (var. *sericeus* Fors ex DC.), which has densely hairy, silver leaves. Both have been widely cultivated as medicinal, ornamental and reclamation plants, especially in India and the Middle East (Barwick 2004).

In its native habitat, *C. erectus* appears to occupy the zone between the mangrove species inundated by salt water and the dry land behind. In cultivation, it thrives on dry soils (away from indigenous mangroves), calcareous clays with a high, brackish water table, and poor sandy soils. Established plants are very drought tolerant and can form extensive thickets by sprawling and rooting where stems touch the ground; even large stems broken by cyclones and floods are capable of rooting on damp ground (Barwick 2004). Plants bear wind pollinated flowers that can produce a large number of small seeds (7,441–23,267 seeds/m²) that are wind and water dispersed, with plants flowering and fruiting throughout the year (Hernandez & Lanza Espino 1999).

Conocarpus in Western Australia

Button Mangrove was probably introduced into Western Australia as part of the North-West Tree Scheme, a State government initiative that aimed to ‘Green the North’. The scheme encouraged widespread planting of trees and other plants in private gardens and reserves and along streets to provide plant

stock suitable for the North-West, control dust and increase shade in the growing population centres of the north. To undertake this initiative, the Broome Tree Nursery was established in the 1960s by the Department of the North-West. The nursery obtained many tropical plants as seeds from overseas and gave away thousands of plants, including native species, citrus trees and tropical fruit trees (Department of Planning, Lands and Heritage 2017-2021).

Material of both species have been imported from overseas into Australia, for many years. For example, the Queensland Acclimatisation Society imported seeds of *Conocarpus* in 1881 (The Queenslander, Brisbane; 17 September 1881, p. 372) and *C. lancifolius* was well established at Woomera and 16 metres tall by 1951 grown from seeds imported from Somalia ('Strangers' settle in Rocketland, Melbourne Herald, 21 February 1951). The town of Karratha, established in 1971, had many shade and amenity trees planted during establishment and subsequently (Edgecombe 1983). No doubt *Conocarpus* was supplied to Karratha as part of the North-West Tree Scheme in the 1970s, either from Australian or overseas material. After searching known collections of ephemeral literature we have been unable to locate any early lists of trees circulated by the Broome Nursery or any records of what seeds were imported or what was planted around Karratha. Broome Nursery lists for 1979, 1984, 1985, 1986 and 1990 were located but *Conocarpus* is not mentioned.

In 2018, one of us (VL) noticed that an unusual, non-native tree species was spreading in creeklines around Karratha and requested that the shire remove the individuals. Subsequently, a naturalised occurrence of over 50 *Conocarpus* plants in a semi-saline creekline was discovered (Figure 1) and vouchered by Jennifer Green (DPIRD, PERTH 09363475). We have identified this material as *C. erectus* due to the presence of salt glands (Figure 2) on the leaf petiole, which are absent in *C. lancifolius* (Barwick 2004; EfloraofIndia 2007-; Hegozy *et al.* 2008), and have assigned it to var. *erectus* on account of its glabrous leaves. Interestingly, soft sparsely hairy to glabrous leaved populations of this variety have been recorded by Semple (1970) from West Tropical Africa and the Atlantic and Pacific coasts of North and South America, suggesting the two varieties may intergrade.

Interestingly, *Conocarpus* is not listed as a permitted genus for importation to Western Australia (Department of Primary Industries and Regional Development 2021). Under the Biosecurity and Agricultural Management Act, all non-native plant species are regarded as an unlisted (s14) organism that are not permitted entry to Western Australia. They must be assessed for weed risk before being permitted for entry (Department of Primary Industries and Regional Development 2021). A current weed risk assessment of *C. erectus* would have denied importation of this species.

Currently there are two specimens of *C. erectus* naturalised in creeks around Darwin at the Northern Territory Herbarium from 2008 and 2010 (Wirf, 539 & Westaway, 3411). There is also a cultivated specimen from Derby, collected in 1999 (Mitchell, 5681), which was determined as *C. lancifolius* (this requires validation).

Button Mangrove has escaped from plantings in Hawaii on the islands of Oahu, Maui, Kauai and the Midway Atoll (Lorence & Flynn 1997; Allen 1998; Wagner *et al.* 1999; Starr & Starr 2008). It has also been recorded as naturalised in Kiribati (Fosberg & Stoddart 1994). Hawaii had no mangroves until 1902 when Red Mangrove (*Rhizophora mangle* L.) was introduced to stabilise mud flats on Oahu. Since then, five mangrove species have been imported and three (*C. erectus*, *Bruguiera gymnorhiza* (L.) Lam. and *R. mangle*) have become naturalised (Allan 1998). Button Mangrove has negative impacts on archaeological sites (fishponds), colonises habitats to the detriment of native Hawaiian species (especially waders and endemic fish), invades *Hibiscus tiliaceus* L. forests and mudflats, and



Figure 1: *Conocarpus erectus*. A – flowers and fruits; B – typical low dense shrub along Jennifer Creek, Karratha. Voucher: L. Martin 1. Image: V. Long.



Figure 2: *Conocarpus erectus* leaves showing salt glands on petiole and green glabrous lamina. Image: V. Long.

causes serious drainage issues. It is listed as a highly invasive species by the Hawaiian State Alien Species co-ordinator and it is recommended that it is not grown anywhere in Hawaii (Randall 2017).

The recording of a weedy mangrove in northern Western Australia is alarming since there are large areas of potential habitat from Carnarvon to the Kimberley for this species to invade. Although the potential impact of this species in Western Australia is unknown, it would be wise not to find out. Every effort to eradicate this population should be undertaken before it can spread further.

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Constructive comments by Juliet Wege greatly improved the flow and information in this paper.

References

- Allen, J.A. (1998). Mangroves as alien species: the case of Hawaii. *Global Ecology and Biogeography Letters* 7(1): 61–71.
- Barwick, M. (2004). *Tropical and Sub-Tropical Trees-A Worldwide Encyclopaedic Guide*. (Thames and Hudson: London.)
- Department of Planning, Lands and Heritage (2017–2021). Our heritage places number 26330. <http://inherit.stateheritage.wa.gov.au> [Accessed 8 July 2021].
- EfloraofIndia (2007–). Database of Plants of the Indian Subcontinent. <https://efloraofindia.com/> [Accessed 20 September 2021].
- Edgecombe, W. (1983). Pilbara gardens for functional beauty. *Landscape* 28: 3–9.
- Fosberg, F.R. & Stoddart, D.R. (1994). Flora of the Phoenix Islands, central Pacific. *Atoll Research Bulletin* 393: 1–60.

- Hegozy, S.S., Aref, I.M., Al-Mefrarrej, H. & El-Juhany, L.I. (2008). Effects of spacing on the biomass production and allocation in *Conocarpus erectus* L. trees grown in Riyadh, Saudi Arabia. *Saudi Journal of Biological Science* 15: 315–322.
- Hernandez, C.T. & Lanza Espino, G. de la (1999). Ecología, producción y aprovechamiento del mangle *Conocarpus erectus* L., en Barra de Tecoanapa Guerrero, Mexico. [Ecology, production and use of the mangrove *Conocarpus erectus* L. from Barra de Tecoanapa Guerrero, Mexico.] *Biotropica* 31: 121–134.
- Lorence, D.H. & Flynn, T.W. (1997). New naturalized plant records for Kaua'i. *Bishop Museum Occasional Papers* 49: 9–13.
- Randall, R.P. (2017). *A Global Compendium of Weeds*, Third Edition. (R.P. Randall: Perth, Western Australia.)
- Semple, J. (1970). The distribution of pubescent-leaved individuals of *Conocarpus erectus* (Combretaceae). *Rhodora* 72: 544–547.
- Starr, F. & Starr, K. (2008). Botanical survey of Midway Atoll. Prepared for: United States Fish and Wildlife Service.
- Thulin, M. (1993, updated 2008). *Flora of Somalia*, Vol.1. (Royal Botanic Gardens, Kew: London.)
- Wagner, W.L., Herbst, D.R. & Sohmer, S.H. (1999). *Manual of the flowering plants of Hawai'i*. Revised Edition, Bernice P. Bishop Museum special publication. (University of Hawai'i Press/Bishop Museum Press: Honolulu.)
- Department of Primary Industries and Regional Development (2021). *Western Australian Organism List*. <https://www.agric.wa.gov.au/organisms> [Accessed 19 October 2021].

The correct name for the weedy *Homalanthus* (Euphorbiaceae) in Western Australia

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SHORT COMMUNICATION

Homalanthus (Euphorbiaceae) is a genus of 23 species of trees and shrubs occurring in tropical Asia, Australia, and some Pacific Islands (Esser 1997; Council of Heads of Australasian Herbaria 2006–). In Australia three species are found: *Homalanthus novo-guineensis* (Warb.) Lauterb. & K.Schum., the Native Bleeding Heart, Native Poplar, Tropical Bleeding Heart, which occurs in Indonesia, Papua New Guinea, Solomon Islands, Northern Territory, Queensland and Western Australia; *Homalanthus populifolius* Graham, the Bleeding Heart, Native Poplar or Queensland Poplar, which occurs in Queensland, New South Wales, Victoria, Papua New Guinea, Lord Howe Island, Norfolk Island and the Solomon Islands; and *Homalanthus stillingiiifolius* F.Muell., which occurs in Queensland and New South Wales and is not further relevant to this paper.

Since the first record in 1999 in Nerrigen Brook, at Armadale, a *Homalanthus* species has been recorded as invading many wetlands in south-west Australia, from Perth to Albany. Plants fruit abundantly and the fruits/seeds are dispersed by water, gravity and a wide range of birds. This commonly grown species appears to be highly invasive of native bushland and the toxic foliage (Quattrocchi 2012) is not eaten by native herbivores. Plants are capable of germinating in intact wetland sites and grow readily under canopy shade. The species is rapidly becoming a significant environmental weed.

These invasive weedy populations were originally allocated to *H. novo-guineensis*, (Western Australian Herbarium 1998–) but recently a collection of this weed by Andrew Mitchell was allocated to *H. populifolius* by Paul Forster at Queensland Herbarium (Forster pers. com.). This raised the issue of whether the weedy plants in south-west Australia were either or both species.

Three species (*H. novo-guineensis*, *H. nutans* (G.Forst.) Guill. and *H. populifolius*) are the only members of the genus where multiple inflorescence bract glands occur and are unlikely to be confused with other members of the genus. *Homalanthus nutans* occurs east of the other species throughout the south-west Pacific from New Caledonia to Samoa but is not recorded as being cultivated in Western Australia, so this species is not considered further in this study. The other two species are closely related and are difficult to separate. Both species are variable through their ranges, may hybridise in contact zones (Airy Shaw 1968) and have been subject to considerable discussion of useful distinguishing characters both in the field and herbarium. In the latest review of the genus affecting the Australian species, Esser (1997) noted that they are not distinguishable by measurements or characters of their leaves, flowers or

fruits. For example, Airy Shaw (1981) recorded that *H. populifolius* had an elongate stigma compared to *H. novo-guineensis*, and used this as a key separation character, but Esser (1997) states that this character completely overlaps with *H. novo-guineensis* and cannot be used to separate the species.

Forster (1994), when he combined *H. populifolius* under *H. nutans* (a decision that was reversed by Esser 1997), noted that *H. populifolius* had glabrous fruits compared to puberulous (hairy-papillate) fruits in *H. novo-guineensis*. Again, however, while they are generally hairy in *H. novo-guineensis*, this is a very variable character and not always consistent (Esser 1997).

In the field *H. populifolius* is recorded as having 1–4 fruits per inflorescence and *H. novo-guineensis* having 2–30, but this is difficult to see on most herbarium collections, which are often not collected in fruit. Plants in the field generally differ in that *H. novo-guineensis* has inflorescences that are normally unisexual, with a much higher number of female flowers per inflorescence. This is a good population/field guide but of limited use with herbarium collections.

Esser (1997) provides what he notes is the only means to separate flowering material of the two species, often the state found in herbarium collections, shown in the following key. Plants bear flowers in a long spike which normally has male flowers in the upper portion and female flowers at the base. The bracts of the clusters of staminate flowers have glands at their base.

1. Inflorescence bract glands in 1–3 pairs, each gland reddish pillow-shaped, uniformly glaucous-papillate. Plant glabrous.....**H. populifolius**
- 1: Inflorescence bract glands in many (at least 4) pairs, each gland cup-shaped, with a shiny green centre and paler glaucous-papillate, usually elevated margin. Plant glabrous or puberulous**H. novo-guineensis**

Using Esser's key, examination of flowering material of all 35 collections held in the Western Australian Herbarium showed that the native plants in the Kimberley corresponded to *H. novo-guineensis*, whereas the southern weedy populations corresponded to *H. populifolius*.

Naturalising material in southern Western Australia originates from garden plants. *Homalanthus populifolius* is currently widely cultivated in Australia for its form and red coloured senescent leaves. Cultivated material mainly comes from New South Wales and Queensland, where the species is common (Forster 2002). *Homalanthus novo-guineensis* is apparently rarely grown, so this is perhaps not unexpected. Finally, *H. populifolius* is also recorded as invasive in New Zealand, Hawaii, South Africa and Sri Lanka, but there are no records of *H. novo-guineensis* behaving as a weed (Randall 2017).

References

- Airy Shaw, H.K. (1968). New or Noteworthy Species of *Homalanthus* Juss. *Kew Bulletin* 21: 409–418.
- Airy Shaw, H.K. (1981). The Euphorbiaceae of Sumatra. *Kew Bulletin* 36: 309–310.
- Council of Heads of Australasian Herbaria (2006–). *National Species List*. <https://id.biodiversity.org.au/name/apni/86360> [Accessed 25 August 2021].
- Esser, H.J. (1997). A revision of *Omalanthus* (Euphorbiaceae) in Malesia. *Blumea* 42: 421–466.
- Forster, P.I. (1994). *Omalanthus nutans* (Euphorbiaceae), the correct name for the native 'Bleeding Heart' or 'Native Poplar' of Australia. *Telopea* 6: 169–171.
- Forster, P.I. (2002). Euphorbiaceae. In: Spencer, R.D. (ed.) *Horticultural Flora of south-eastern Australia. Vol. 3. Flowering Plants. Dicotyledons, Part 2. The Identification of garden and cultivated plants*. (University of New South Wales: Press, Sydney.)

- Quattrocchi, U. (2012). *CRC World Dictionary of Medicinal and Poisonous Plants*. (CRC Press, Taylor and Francis: London.)
- Randall, R.P. (2017). *A Global Compendium of Weeds*. Third Edition. (CRC Weeds: Mount Helena, Western Australia.)
- Western Australian Herbarium (1998–). *Florabase—the Western Australian Flora*. Department of Biodiversity, Conservation and Attractions. <http://florabase.dbca.wa.gov.au/> [Accessed 10 August 2021].

***Austrostipa* (Poaceae) in Western Australia: new species, new records, keys, and character notes**

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Abstract

Williams A.R., *Austrostipa* (Poaceae) in Western Australia: new species, new records, keys, and character notes. *Nuytsia* 33: 39–101 (2022). *Austrostipa* S.W.L.Jacobs & J.Everett is a monophyletic genus of temperate Australian native grasses that occur throughout the southern part of the continent and in New Zealand. Eight new species from Western Australia are described and illustrated here, plus two newly recorded species that are range extensions from their previously known habitats in South Australia, bringing the total number of species recorded in this state to forty-four. Detailed character notes and a key to the species and the accepted subgenera are provided. The new species are: *A. anaiwaniorum* A.R.Williams, *A. burgesiana* A.R.Williams, *A. everettiana* A.R.Williams, *A. frankliniae* A.R.Williams, *A. heteranthera* A.R.Williams, *A. koordana* A.R.Williams, *A. munaginensis* A.R.Williams and *A. turbinata* A.R.Williams. One former species (*A. mullanulla* J.Everett & S.W.L.Jacobs) has been reduced to synonymy with *A. vickeryana* J.Everett & S.W.L.Jacobs. The two species with range extensions are *A. echinata* (Vickery, S.W.L.Jacobs & J.Everett) S.W.L.Jacobs & J.Everett, which has been found at several sites around Esperance, and *A. mundula* (J.M.Black) S.W.L.Jacobs & J.Everett, which has been found in numerous small isolated coastal pockets around the south-west and up as far as Yanchep north of Perth. Five of the new species appear to be rare and isolated, including the newly discovered populations of *A. echinata* and *A. mundula*, and warrant conservation priority.

Introduction

Spear grasses in the genus *Stipa* L. occur in temperate, subtropical, and tropical mountain grasslands worldwide (Plants of the World Online). Jacobs and Everett (1996) found the Australian species to be monophyletic, based upon a combined study of molecular and morphological characters, and separated them into a new genus *Austrostipa* S.W.L.Jacobs & J.Everett. Similar conclusions were drawn by Jacobs *et al.* (2000), Romaschenko *et al.* (2010) and Bustam (2010), but more recent studies by Winterfeld *et al.* (2015) and Tkach *et al.* (2021) have not supported monophyly. *Austrostipa* is a strictly temperate genus in Australia and New Zealand. In Western Australia (WA) its species occur mostly in the south-west, from Shark Bay in the mid-north across to the Nullarbor Plain along the southern part of the border with South Australia.

The genus was treated by Everett *et al.* (2009) in volume 42A of the *Flora of Australia*, but this treatment was a summary extract from the more detailed revision of the Australian species (then *Stipa*) by Vickery *et al.* (1986) plus one new WA species (*A. geoffreyi* S.W.L.Jacobs & J.Everett) described in Jacobs

and Everett (1996). Jessop *et al.* (2006) in their *Grasses of South Australia* likewise extracted their information from Vickery *et al.* (1986) for their *Austrostipa* chapter, but they also included helpful notes from their own observations. Williams (2011) described two new rare WA species from the Swan Coastal Plain. Eight other new WA species have since been identified in collections held at PERTH and are described and illustrated here, while several character descriptions and clarifications are included that have not been published previously. A combined key to all WA subgenera and their species is provided. Herbarium abbreviations follow *Index Herbariorum* (Thiers 2014).

Methods

All specimens within the genus in the PERTH herbarium were examined morphologically in the period 2001–2003, and I continued to carry out specialist study of the collection through to 2019. Specimens that were significantly different from the published descriptions were given phrase names and all taxa were compared using the query facilities in the Intkey interface to a DELTA database (T.D. Macfarlane unpubl.) constructed from Vickery *et al.* (1986) and updated by me to reflect additions from newer collections since that time. Digital images were prepared using proprietary software Corel PhotoPaint, Helicon Focus and BeFunky, while vector illustrations and composite images were prepared using CorelDraw. IBRA 7 bioregions were taken from DSEWPC (2013).

Most of the new species described here were found to be very distinctive once the material had been adequately studied, but in two cases (the Ravensthorpe Ranges collections now known as *Austrostipa heteranthera* A.R. Williams and *A. turbinata* A.R. Williams, and the question of separate species status in *A. vickeryana* J. Everett & S.W.L. Jacobs and *A. nullanulla* J. Everett & S.W.L. Jacobs) multivariate numerical analyses were required to achieve clarity. In both cases the PAST statistical package (version 4.03, Hammer *et al.* 2001) was used, together with the Box-Cox character transformations (Box & Cox 1964) to mitigate biases in the data caused by different measurement scales and to transform each variable to an approximately Normal distribution. This allowed the data to be explored with a wide range of analytical methods. The standardised list of characters used is given in Table 1, measurements were all based on dried and usually mounted herbarium specimens, and the relevant analytical methods are listed under the appropriate sections, with details of results given in figure legends.

Important Characters

Vickery *et al.* (1986) devoted several pages to character definitions and illustrations, and Jacobs *et al.* (1996) published images and definitions of some lemma apex characters that distinguish native Australian *Stipa* from the introduced weedy species of *Nassella* E. Desv. Tkach *et al.* (2021) presented a collection of SEM images of lemma surface cells in Australasian *Stipeae* spp. which provide clarity in terminology. Some new characters were discovered in this present study, and several existing characters required clearer definition, so these are described here before the taxonomic treatment.

Habit development

The grass habit differs from most other herbs in that the apical meristem remains vestigial at the base of the plant during the early stages of vegetative growth. The first visible shoots are a series of concentric leaf sheaths that develop around, but extend above, the basal meristem, and when the meristem later elongates to form the culm, it elevates the leaf nodes (together with their sheaths and emerging leaf blades) in sequence on successively elongating internodes. One potentially useful

character arising from this developmental sequence in mature plants is whether the nodes either remain ‘enclosed’ within the preceding leaf sheath or emerge above it and become ‘exposed’ to view.

If the growing season is long enough, new lateral shoots (tillers) can arise from the base and develop in a similar manner. Each new shoot is accompanied by an adventitious root system. Some shoots can grow horizontally and produce new shoots and adventitious roots at each node to form an underground rhizome, but above-ground stolons do not occur in *Austrostipa*; and, as in all grasses, tap-roots do not form so all roots are adventitious.

Most *Austrostipa* species are perennial, in which case at least some of the vegetative growth must persist to protect the basal meristem from desiccation during the long dry season, typically from October to May in south-west WA. This is usually accomplished by culm bases persisting after flowering. In some cases, however, the dead stems can disintegrate down to soil level during the winter wet season and new stems emerge from underground in spring. Both species that have been placed in *A.* subg. *Longiaristatae* S.W.L.Jacobs & J.Everett (*A. compressa* (R.Br.) S.W.L.Jacobs & J.Everett and *A. macalpinei* (Reader) S.W.L.Jacobs & J.Everett) are exclusively annual species in WA and grow from seed each year, often only after fire, but all the new species described here appear to be perennials.

Vickery *et al.* (1986) separated the extravaginal branching condition from rhizomatous forms but did not explain the terminology they used to distinguish rhizomatous states; they also used the term ‘innovations’ for what others have called tillers. Clearer definitions relevant to present needs are provided by Briske (1991):

‘The spatial arrangement of tillers within the grass plant ... is a major determinant of architectural variation within the grass growth form (e.g., bunchgrasses versus sodgrasses). ... **Intravaginal tiller development** within the subtending leaf sheath results in a compact spatial arrangement of tillers defining the **bunchgrass** (caespitose or tussock) growth form. Contrastingly, **extravaginal tiller development** proceeds laterally through the subtending leaf sheath contributing to greater inter-tiller distance and tiller angles within the plant. Extravaginal tiller development is a prerequisite to the formation of the **sodgrass** (creeping or spreading) growth form which may be further accentuated by the development of rhizomes and stolons [emphases in original].’

Thus, a rhizome is an extension of an extravaginal branch, but an extravaginal branch does not necessarily produce a rhizome.

The term ‘sodgrass’ is somewhat misleading in much of mainland Australia where climate and habitat prevent the development of a year-round turf-like growth in perennial grasses. In virtually all places where *Austrostipa* occurs in WA, the plants are found as discrete tussocks, some with the ‘bunchgrass’ structure and some with the ‘sodgrass’ structure, because the growing season is too short, and the habitat is too variable to support the development of larger perennial swards.

Normally the aerial parts of a grass plant grow straight up when they are free to do so. When an extravaginal branch with sufficient internode length is present, new tillers are free to grow straight upwards without interference from adjacent shoots on the preceding node, so a rhizome develops. If conditions allow continued growth in this way a dense erect sward will result. However, if the extravaginal branch is too short, each new shoot must emerge at an angle until it is free of interference from adjacent shoots, after which it may bend at the first node towards vertical, thereby creating a

‘geniculate culm’. This produces a more open or spreading tussock pattern, like the usual condition with intravaginal branching.

In the intermediate case when a short rhizome is present, the angle at which new shoots emerge can be complicated by the behaviour of the culm and sheaths on the adjacent shoots. If the sheaths grow high and clasp tightly to their culms there will be little interference and a dense erect sward of tightly packed culms and tillers will result. But the presence of a short rhizome can become obscured if the culm bases are swollen, or if adjoining sheaths grow initially as multiple short cataphylls, or if they expand and/or draw back early from their culms. In all these cases, there may be sufficient interference between shoots to spread out the tussock structure. Spreading may also be exacerbated in old perennial tussocks when persistent culms or sheath bases from previous seasons remain intact and/or become infiltrated with soil or plant debris.

Four of the species included here (*Austrostipa heteranthera*, *A. turbinata*, *A. everettiana* A.R. Williams and *A. mundula* (J.M.Black) S.W.L.Jacobs & J.Everett display the sodgrass habit, while all the species that share the nearest morphological similarity to them (*A. flavescens* (Labill.) S.W.L.Jacobs & J.Everett, *A. puberula* (Steud.) S.W.L.Jacobs & J.Everett and *A. eremophila* (Reader) S.W.L.Jacobs & J.Everett) have a fairly open tussock structure with one or more geniculate culms. The leaf sheaths in these latter species are generally short at first, sometimes producing several cataphylls, and they quickly peel back from the culms. The leaf blades emerge at an angle to the sheath, the flowering culms are conspicuously broader than the more mature tillers, and sometimes the flowering culms have a swollen base. A specimen of *A. flavescens* that displays all these features is shown in Figure 1A together with a specimen of *A. puberula* collected from the Mt Holland site (Figure 1B). In contrast, the new taxa produced densely packed tussocks consisting of erect shoots, clearly indicating the presence of a short rhizome. The leaf sheaths clasp tightly around their culms, the blades arise erectly from the sheaths, and it is difficult to distinguish between tillers, flowering culms, sheaths and leaf blades, as illustrated in Figure 1C, 1D & 1E for *A. heteranthera*, *A. turbinata* and *A. everettiana* respectively. In *A. mundula* (Figure 1F) the sheaths clasp tightly to the culms and the leaf blades arise erectly from the sheaths but in such a way that they usually produce a continuous arc across the whole blade, the sclerophyllous tissue stiffly maintaining the smooth curvature. This unique feature is quite outstanding in both the holotype of *A. mundula* and in the WA specimens assigned to this name.

Habit development was scored in multivariate analyses as a single variable where 0 = densely packed erect culms, and 1 = open structured tussocks.

Panicle structure

In most *Austrostipa* species the panicle has a conical shape, with the lower branches being the longest and the upper branches tapering towards a single apex. The internodes within the panicle axis are usually short enough for the lower branches to overlap them in the juvenile unopened state, and usually in the mature state as well (although sometimes the lowest node in the panicle can be depauperate, bearing one or more aborted spikelets on very short and undeveloped branches). Most panicles also carry dozens of spikelets. In four of the new species, however, there are only few spikelets, and on two of them (*A. koordana* A.R. Williams and *A. burgesiana* A.R. Williams), the lower nodes have their spikelets crowded together on very short branches that do not overlap the long panicle internodes. Figure 2 illustrates a range of panicle structures in WA species, which provides a context within which to evaluate the distinctiveness of the new species.

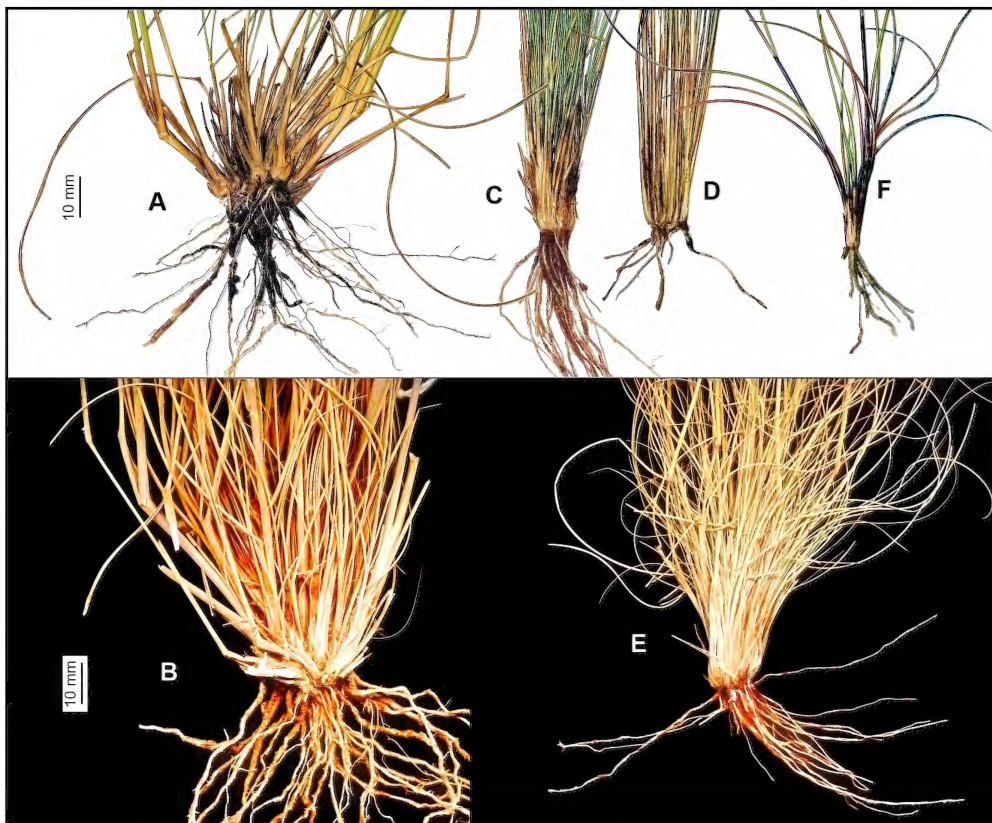


Figure 1. Tussock base variations in some new species of *Austrostipa* compared with related existing species. A & B – tussock structure open, with broad, geniculate flowering culms in A – *A. flavescens* and B – *A. puberula*; C– F – tussocks dense, with narrow and erect flowering culms in C – *A. heteranthera*, D – *A. turbinata*, E – *A. everettiana* and F – *A. mundula*. Scanned images by the author from T.E.H. *Aplin* 6463 (A); A. Dooley AD433 (B); A. Markey & J. Allen 6264 (C); S. Kern & R. Jasper LCH18459 (D); A. Dooley AD428 (E); G J. Keighery & J.J. Alford 644 (F).

Austrostipa puberula has a somewhat reduced but otherwise standard panicle shape (Figure 2A), *A. pycnostachya* has many spikelets crowded together on short branches (Figure 2B), *A. trichophylla* Benth. has few spikelets on short branches distributed evenly along the panicle axis (Figure 2C), *A. geoffreyi* has many spikelets crowded on short branches but with longer basal internodes (Figure 2D) and *A. platychaeta* has few spikelets at the ends of evenly spaced long open branches (Figure 2E). *Austrostipa turbinata* (Figure 2F) is similar to *A. heteranthera* in having a much-reduced panicle with few spikelets. Both *A. burgesiana* and *A. koordana* (Figures 2G and 2H) have few spikelets on short branches but with long basal internodes. *Austrostipa elegantissima* (Figure 2I) has few spikelets at the end of long, evenly spaced, widely spreading, and unusually hairy branches; the florets remain attached to the panicle at maturity and the whole panicle acts as a single diaspore breaking off and blowing away in the wind.

It is sometimes difficult to count the actual number of spikelets on mounted specimens, so a simplified binary scale was initially used to reflect this condition: 0 = few (≤ 20); 1 = many (≥ 20). However, in the multivariate analyses the relevant species had sufficiently similar panicle branching patterns that panicle length could be used as a suitable correlate for spikelet number.

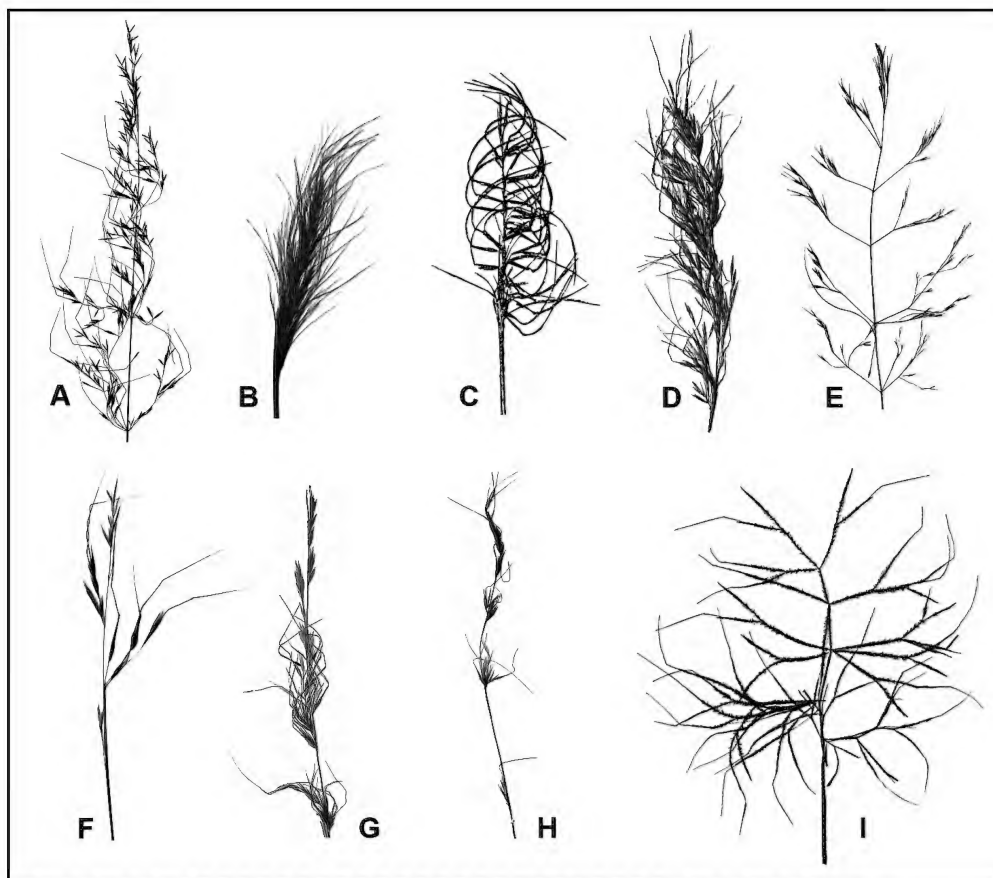


Figure 2. Panicle shape variations in *Austrostipa* (not to scale). Images were scanned from dried and pressed specimens — in life the branches are whorled around the central panicle axis. Distinctive characteristics are noted in the text. A – *A. puberula*; B – *A. pycnostachya*; C – *A. trichophylla*; D – *A. geoffreyi*; E – *A. platychaeta*; F – *A. turbinata* (*A. heteranthera* is similar); G – *A. burgesiana*; H – *A. koordana*; I – *A. elegantissima*. Images prepared by the author based on *A. Dooley* AD 433 (A); *M.N. Lyons & S.D. Lyons* 3401 (B); *K.R. Newbey* 6457 (C); *A.S. George* 10466 (D); *G.J. Keighery* 4371 (E); *A. Markey & J. Allen* 6263 (F); *A.A. Mitchell & P.J. Waddell* 10499 (G); *Anonymous* s.n. PERTH 08730202 (H); *R. Spellenberg & N. Zucker* RS 9469 (I).

Floret development

The progress of *Austrostipa* floret development and its different stages of maturation, especially anther development and the induration of the lemma and palea, was discovered to be of special significance in the identification of some of the new species. These findings also contradicted some parts of the genus description and key characters given in recent literature, notably the chapter on *Austrostipa* in the *Flora of Australia* (Everett *et al.* 2009).

Austrostipa floral anatomy is largely similar to that of grasses in general and is distinctive mainly because the single terminal awn on the lemma and the sharp callus at the base of the lemma turn the mature floret into a stiff and robust ‘miniature spear’ that in some species at least easily penetrates human clothing and animal hair.

Crucial differences begin to appear after the ‘boot’ stage when the plants’ physiology switches priority from vegetative production to seed production. Some species can be identified only when fully mature, but this is a difficult stage to catch because very soon after the floret matures it dehisces from the rachilla and falls away.

Important stages in *Austrostipa* floral development are illustrated in Figure 3. As shown in Figure 3A, a typical early-stage floret of *A. puberula* (with lemma and palea removed) has a bifid style with two lacinate stigmas and three immature anthers, of which the large green anterior one [left] develops before the two posterior ones [either side of the carpel in the image]; below these are the anterior [left] and posterior [right] lodicules. Mature lodicule number (2 or 3), size, and shape can have taxonomic value in some species, but the lodicules often adhere to the inner surfaces of the lemma and palea and are thus difficult to find when dissecting fully mature florets, so they have not been used as key characters in this study.

At anthesis, a freshly collected spikelet of *A. puberula* (Figure 3B) has all anthers equal-sized. The lodicules have swollen up and forced the lemma and palea to open, exposing the stigmas (white) and three undehiscent anthers (green tinged with red). The anther filaments have elongated to ensure that when the anthers dehisce the pollen can disperse in the wind. Figures 3C and 3D (*A. juncifolia* and *A. eremophila* respectively) show two dried specimens that were collected at anthesis — the filaments have contracted due to drying but the enlarged yet undehiscent anthers are now too big to fit back inside the floret.

Cleistogamy is illustrated in Figure 3E for *A. puberula*; only a single point mutation (Nair *et al.* 2010) is required to block lodicule development so that the lemma & palea remain closed. All three anthers have developed to sexual maturity without significant pigmentation, and all are shorter than those in Figure 3B (compare scale bars); they have dehisced inside the closed floret and the pollen granules (visible in the image) have probably already self-fertilised the ovary.

An aberrant anther syndrome found in three of the new species is described and reported here for the first time. A spikelet of one of the species, *A. heteranthera*, is illustrated at sexual maturity (Figure 3F). The large anterior anther has matured and dehiscent inside the floret (pollen grains can be seen still clinging to the anther), resulting in self-fertilisation, while the posterior anthers have remained undeveloped as staminodes. Anthers of the other two species, *A. heteranthera* and *A. turbinata*, are illustrated in Figures 3G and 3H.

Austrostipa species generally have three opaquely pigmented anthers, all approximately the same size, and usually ≥ 2 mm long. Those in *A. juncifolia* and *A. eremophila* (Figures 3C and 3D) are typical and illustrate the dramatic difference between the aberrant and normal anther conditions. Clifford (1987) noted that the aberrant anther syndrome can occur in some species of non-Australian *Stipa* where only the anterior stamen matures, leaving the other two (posterior) stamens undeveloped and shorter, but this character had not previously been reported in *Austrostipa*.

For the multivariate analyses, anther colour was scored as 0 = colourless and/or translucent, 1 = opaquely pigmented, and anther length (mm) was scored twice — once for the longest (anterior) and once for the shortest (posterior) pair.

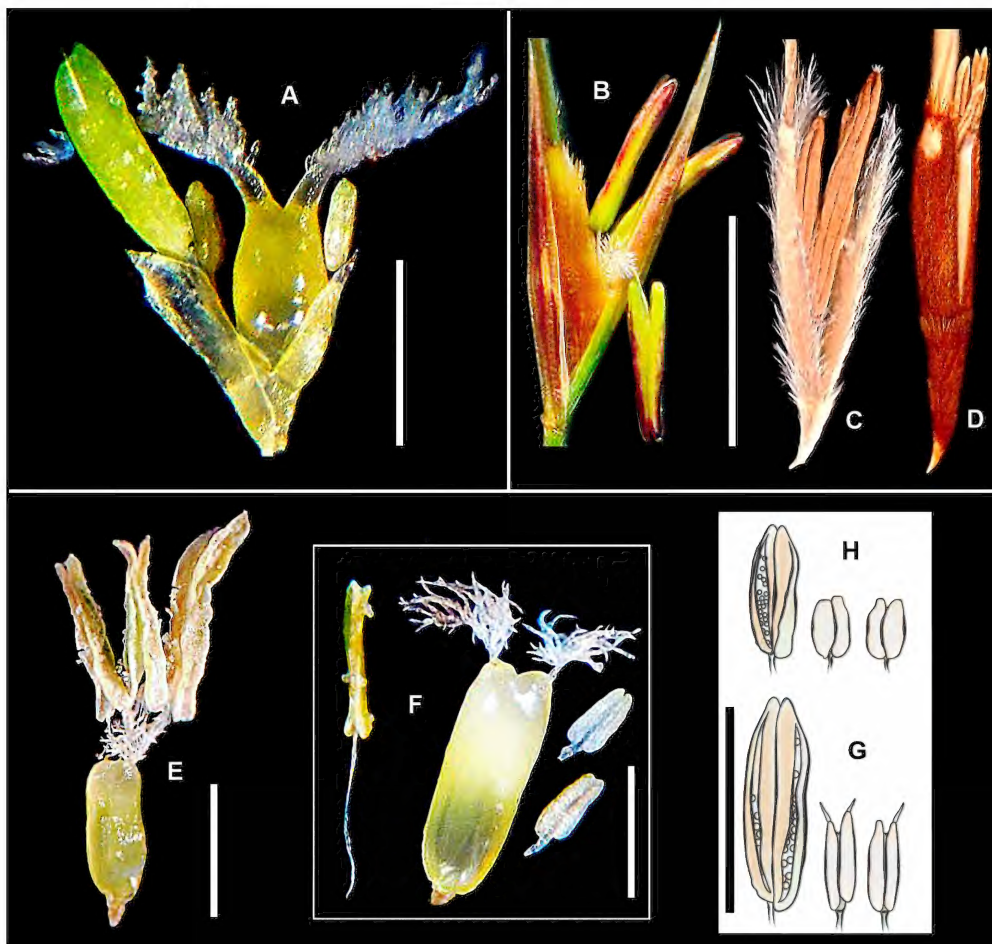


Figure 3. Floral development in *Austrostipa*. A – contents of a normally-developing floret of *A. puberula* at early ‘boot’ stage with the lemma and palea removed; B – A normally-developed chasmogamous spikelet of *A. puberula* at early anthesis where all organs have developed fully but have not yet sexually matured; C – dried floret of *A. juncifolia* which was collected at anthesis showing the mature but undehiscent anthers still inside; D – dried floret of *A. eremophila* collected likewise at anthesis; E – the contents of a cleistogamous floret from *A. puberula*; F – aberrant anther syndrome at sexual maturity, as found in three of the new species; G – vector illustrations of re-hydrated anthers from a dried specimen of *A. heteranthera*; H – vector illustrations of re-hydrated anthers from a dried specimen of *A. turbinata*. Images A, B, E and F were prepared by the author from photographs supplied by Elizabeth Sandiford who collected and dissected fresh material from around Ravensthorpe in October 2013; EMS 145 (A); EMS 26 (B); EMS 219 (E); EMS 190 (F). Vector drawings were based on *A. Markey & J. Allen* 6267 (G) and *A. Markey & J. Allen* 6263 (H). Floret scans C and D were taken from *R.D. Royce* 6063 and *A.S. George* 8478 respectively. Scale bars are 1 mm in A, E and G, H; and 5 mm for B, C and D.

Floret induration

As a general principle, plants grow via cell divisions in specialized meristem regions. Parent meristem cells divide into two halves, each of which then elongates in a direction orthogonal to the plane of division to restore their previous size. As new cells move out of the meristem region, they elongate further until they reach their adult size and, finally, they differentiate into their adult form (which depends upon their position within the plant). The cell walls in the developing *Austrostipa* floret

are flexible enough to enable this growth to occur by having their cellulose fibres elongate through the polymerization of new monomers into their growing regions during the elongation phase. Once maturity is reached, however, the cellulose walls harden to provide a rigid structure that protects the seed during dispersal.

However, hardened cellulose walls only produce things like chaff, leaves, and grass stalks, while the mature *Austrostipa* floret is as hard as the hardwood in a forest tree! Not surprisingly perhaps, the cause is the same in both cases. Rigidity in the mature *Austrostipa* ‘spear’ is achieved via progressive lignification of the cellulose cell walls (Barossy *et al.* 2015) which thereby also prevents any further cell growth, and its rigid spear-like structure provides specifically directed assistance to its dispersal function. The freely-falling mature floret is easily displaced and carried away via contact with animals; its barbed point strengthens its hold on such animal vectors; when it falls to the ground the weighted point aids in reaching towards and penetrating the soil; when damp conditions arise, the twisted column absorbs moisture and expands, causing it to unwind, and this twisting action ‘drills’ the pointed diaspore into the ground and assists in promoting germination. Geniculate and twisted awns like these are more successful in dispersal and burial in soil than straight awns (Cavanagh *et al.* 2019).

Observations during this study indicated that there is a standard sequence of tissue lignification during floret maturation and understanding this sequence is a useful aid to identification. The base of the floret (above the stipe) hardens first around its outer margins to provide strong points of attachment for the lemma and palea, but the inner region retains functional vascular tissue to allow the free flow of nutrients and moisture to promote development of the sex organs and the caryopsis on the inside. Then the outer surfaces of the lemma and palea harden before their inner surfaces, and this provides protection from desiccation while the caryopsis matures and expands to its full size. Last of all the caryopsis swells and hardens at maturity. When the floret is fully mature the vascular bundles in the stipe are sealed off at a sharp angle, a layer of spongy mesophyll develops in the abscission zone, the vascular supply vessels in the rachilla are sealed off, and only a small amount of force is then required to break the spongy tissue and release the mature floret from within the glumes. The sharp angle of abscission results in a sharp point, called the callus, on the end of the ‘spear.’ Only in the group that has been named *A. subg. Petaurista* S.W.L.Jacobs & J.Everett do the florets remain firmly attached to the panicle, which breaks off at maturity from its subtending culm and the whole panicle becomes the dispersal unit (diaspore).

Important stages in floret and awn induration are illustrated in Figure 4. Figure 4A shows an abundantly flowering panicle where the awns are all approximately straight and easily recognizable in the field. Figure 4B shows a typical young green *Austrostipa* floret (without hairs) showing the lemma, palea, stipe, collar, and three-cornered (triquetrous) awn. Figure 4C shows two typical mature lemmas with twisted awn columns (in *A. nunaginensis* and *A. blackii*). Figures 4D and 4E show a mature chasmogamous floret of *A. eremophila* (with hairs scraped off), showing the exposed palea (now known to be the dominant mature condition within the genus) and the position at the base of the lemma (circled) where lignification begins (4D), and the cross-section shows the lemma and its relation to the palea (4E). Figures 4F and 4G illustrate a cleistogamous floret of *A. vickeryana* (without hairs), showing how the lemma completely encloses the palea (4G); the position at the base of the lemma where lignification begins (circled) shows that early growth of the lemma begins with diverging margins which subsequently converge again to cover the palea (4F). It is worth noting here that the chasmogamy/cleistogamy distinction in *Austrostipa* is caused by the function or failure, respectively, of the lodicules and not by the exposure or closure of the lemma around the palea.

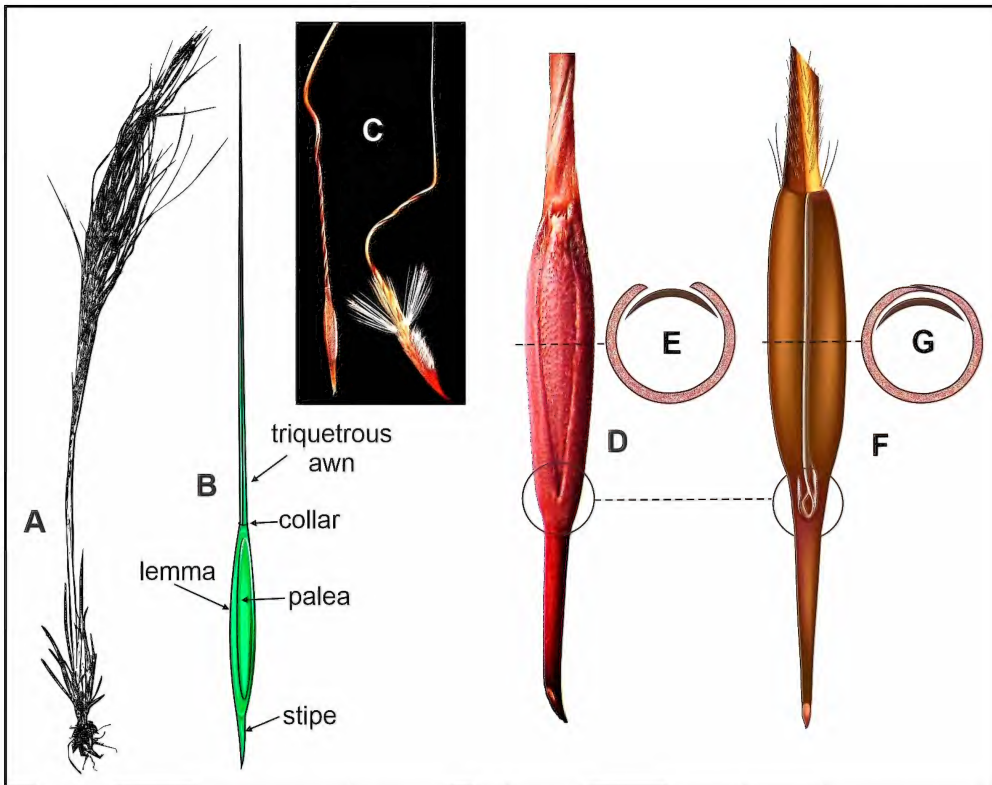


Figure 4. Important stages in floret and awn induration. A – immature green *Austrostipa* plant (vector outline of *A. compressa*); B – schematic diagram of a generic immature green *Austrostipa* floret; C – two mature florets showing brown colours resulting from lignification and twisting of the awn column; D – photograph of a typical mature chasmogamous floret (*A. eremophila*), scraped clean of hairs, showing the exposed palea and the lemma margin opening at the base (circled); E – schematic cross-section of the lemma and palea; note the obtuse edge of the lemma margin; F – vector drawing of a cleistogamous floret (*A. vickeryana* without hairs); the palea is entirely enclosed within the overlapping lemma margins, which are initially open at the base and subsequently closed (circled); G – schematic cross-section of the floret showing the tapered lemma margins fully enclosing the palea. Illustrations and photographs by the author from N. Hoyle 977 (A), M.E. Trudgen MET 21176 (C, left), T.J. Read 5147 (C, right), T.E.H. Aplin 1662 (D, E), W. O'Sullivan WOS303 (F, G).

A matter of practical consequence for identification to species level is that in the south-west of WA the peak wildflower season is in September, a time of year when *Austrostipa* plants are still quite immature. Such immature plants are often collected, however, because the panicle with its collection of 'spears' is distinctive even when green and the awns are still straight. When such specimens are dried the awns usually twist along the column and curl along the bristle (if relevant) into their mature shapes, and the question arises as to whether these immature specimens are at all useful for identification purposes, or whether they give universally misleading results.

Because elongation of newly divided cells is mostly parallel to the long axis of the floret, and because hairs generally elongate outwards from the epidermis in similar manner, it seems safe to suggest (and consistent with my experience) that the length of the lemma and awn, and the length of hairs, may be reasonably reliable guides to the mature state by the time the panicle emerges from within the flag-leaf sheath. In contrast, however, the condition of the lemma and its relation to the palea can be entirely misleading in this immature state — such determinations can only be made on mature material collected late in the growing season (usually November or December) just before seed-fall.

In most species and collections of *Austrostipa* at PERTH, and in loan material from other Australian herbaria, the lemma margins overlap and completely enclose the palea, and this is used as a defining character of the genus in the *Flora of Australia* (Everett *et al.* 2009). In contrast, however, an outstanding feature in one of the new species (*A. everettiana*) was that the lemma indumentum was sparse enough (in the recently collected, pressed, and dried specimen which I examined) to clearly reveal that the lemma margins were drawn back to expose the palea, a defining character previously found only in *Austrostipa lanata* (Vickery, S.W.L.Jacobs & J.Everett) S.W.L.Jacobs & J.Everett. But when I re-examined this new material several months later the exposed paleas had disappeared because the lemma margins had closed in around them. Further drying of the material in the controlled conditions of the Herbarium had apparently created the overlapping lemma condition as an artefact of two compounding factors: (1) the initial collection of *A. everettiana* was immature, even though lignification of the outer lemma and palea surfaces had begun; and (2) the reproductive components inside the floret continued to dry and shrivel for about a year after collection. Consequently, when mature specimens were collected late in the following growing season the exposed palea condition remained a constant feature because the hardened caryopsis now completely filled the floret interior.

In many other species, in contrast, the lemma indumentum is so dense that it obscures the lemma margins in relation to the palea. A survey was therefore carried out on selected immature and mature florets from all subgenera, and the hairs were scraped away with the side of a sharp scalpel blade to expose the lemma margins. This revealed a consistent pattern — in at least some species within all groups (except *Petaurista*) the lemma margins were drawn back to expose the palea in mature specimens, but they entirely enclosed the palea in immature specimens. In particular, the four subgenera listed in the *Austrostipa* key in the *Flora of Australia* (Everett *et al.* 2009) as having overlapping lemma margins (*Eremophilae* S.W.L.Jacobs & J.Everett, *Lancea* S.W.L.Jacobs & J.Everett, *Longiaristatae* and *Ceres* S.W.L.Jacobs & J.Everett) all displayed non-overlapping lemma margins in mature specimens (except for the newly described *Austrostipa turbinata* in *Eremophilae*).

This discovery requires two corrections to the *Austrostipa* chapter in the *Flora of Australia* (Everett *et al.* 2009). First, overlapping lemma margins should be removed from being one of the defining characters of the genus. Second, the subgenus key Couplet 9 on p.16 is no longer correct because it makes a contrast between ‘lemma margins not overlapping’ which separates *A. subg. Aulax* S.W.L.Jacobs & J.Everett, and the alternative ‘lemma margins overlapping’ which separates *Ceres*, *Longiaristatae*, *Lancea* and *Eremophilae*, all four of which are represented in the PERTH collection and most species in them contradict this description.

The geometry of the lemma margins involved in palea exposure is of an entirely different kind to the temporary divergence of the lemma and palea during anthesis — which is due to the swelling of the lodicules to expose the sex organs to fertilisation. Nor is it a late-appearing divergence produced by the swelling of the maturing caryopsis which could theoretically force the lemma margins apart. The circled regions in Figures 4D and 4F illustrate this point. In Figure 4D the lemma margin curvature that creates the obovate opening to expose the palea begins smoothly from the saddle-shaped opening at the top of the callus. In Figure 4F there is a similar saddle-shaped opening at the top of the callus, but the lemma margins then curve back again to create a complete covering for the palea. This geometry suggests that palea exposure is perhaps the more primitive feature.

These results show that there is a chronic difficulty in studying herbarium specimens of *Austrostipa* because a large proportion of them have immature florets. This is not the result of inadequate collection expertise or methodology but rather of the fact that *Austrostipa* florets generally fall from their spikelets very soon after the caryopsis matures. An immature plant that still has its distinctive spear-shaped

florets intact is easy to see in the field and clearly differentiates it from most other grass genera, but after the mature florets have fallen the plants become very much less conspicuous, and because they are now also incomplete (i.e., lacking their florets) they are much less likely to be collected as voucher specimens.

Lemma surface texture and indumentum

Lemma surface texture and indumentum are important characters for distinguishing species and some illustrations and clarifications of terminology are required. Vickery *et al.* (1986) described the lemma surface throughout the genus as varying from ‘quite smooth’—for which their exemplar was *Austrostipa lanata*, illustrated with an SEM image—to ‘almost crystalline or granular’ which they illustrated in two other species ([*A.*] *ramosissima* (Trin.) S.W.L.Jacobs & J.Everett, and [*A.*] *pubescens* (R.Br.) S.W.L.Jacobs & J.Everett), where they described the surface features as ‘tubercles.’ They chose the latter term as the basis for the name of their *A.* subg. *Tuberculatae* S.W.L.Jacobs & J.Everett, which contains species having these lemma surface features (Jacobs & Everett 1996). Their key characters for this subgenus were listed as ‘Lemma glabrous only in the top half, the glabrous portion rough, tuberculate or ‘crystalline’ (with individual small bumps or ridges of translucent silica).’

Jessop *et al.* (2006) published drawings that included the lemma shoulder region in *A. oligostachya* (Hughes) S.W.L.Jacobs & J.Everett and *A. pubinodis* (Trin. & Rupr.) S.W.L.Jacobs & J.Everett, two species within subg. *Tuberculatae*, showing smoothly rounded bumps in the former species (their Figure 50) and bulbous-based scabrous hooks in the latter (their Figure 51).

Bustam (2010) used six micro-morphological characteristics of the lemma in her study of the subgenus structure within *Austrostipa*, and these included what she described as ‘hooks’ and ‘silica bodies’ that presumably refer to the same features illustrated in Vickery *et al.* (1986) and Jessop *et al.* (2006). Bustam (2010) included three species from subg. *Tuberculatae* in her study but found that micro-morphological characters could not be matched to subgenus structure in general; however, they are usually consistent in florets across panicles and clearly distinguish between individual species, and obviously they set species in subg. *Tuberculatae* apart from all others.

Tkach *et al.* (2021) recently presented a collection of SEM images of lemma surface cells in Australasian *Stipeae* spp. which are of assistance in clarifying what earlier authors have described in words. They distinguished five different surface features: long cells (which make up most of the lemma surface), silica cells, cork cells, hooks (tubercles with a curved apical hair) and macro-hairs.

In my studies of specimens at PERTH I found that there are usually some visible features of the cellular sub-structure of the lemma surface at 40× magnification even in species with ‘smooth’ lemma surfaces such as *Austrostipa lanata* and *A. vickeryana*, and sometimes these mature and lignified surfaces can be described as ‘shiny’ or even ‘glossy’. However, there is nothing else like the newly described *A. burgesiana*, which has smoothly rounded bumps all over the sparsely haired main body of the lemma, some further excrescences around these bumps, tuberculate hairs, and tuberculate scabrous hooks in the otherwise glabrous shoulder region, so it clearly belongs in subg. *Tuberculatae* (Jacobs & Everett 1996) which has no other representatives in WA. The ‘translucent silica’ associated with all these surface features in subg. *Tuberculatae* is laid down on top of the lignified floret cells, as is evidenced by the damage caused by scraping the surface with a scalpel blade, so it must have been excreted from the surface cells either before or during the process of lignification. Furthermore, the ‘glossy’ surface in this case is almost mirror-like in reflecting strong light, and the translucent surface

coating of silica visibly sits on top of the lignified cellular surface. Based on Tkach *et al.* (2021) it seems likely that this glossy silica covering is produced by the ‘silica cells’ that are scattered amongst the lignified ‘long cells’.

Figure 5 illustrates important features of the lemma surface, with special attention also given to the differentiation in the indumentum between callus and lemma, as well as special features of the shoulder and neck regions of the lemma. Points to note in each case are given in the figure legend.

The technique of removing hairs from the lemma surface by scraping with the side of a sharp scalpel blade can reveal important properties of the indumentum. Normal lemma hairs can be removed entirely at their base, leaving the lignified lemma surface smooth and undamaged. The dislodged hairs

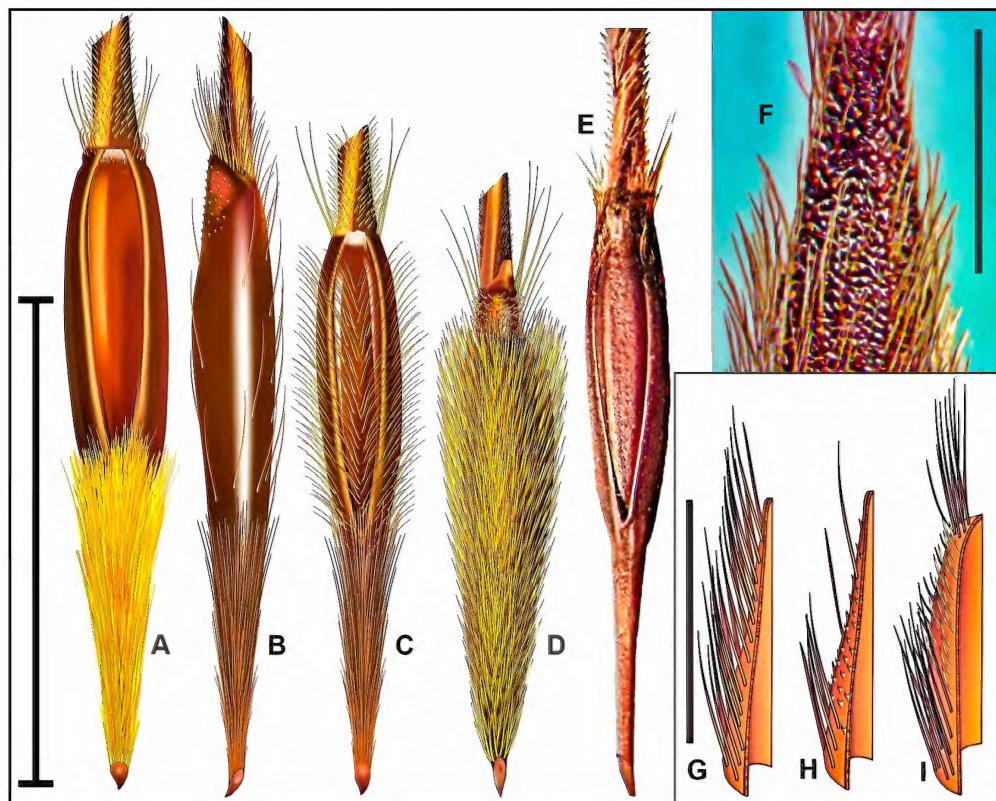


Figure 5. Lemma surface, indumentum, and shoulder ornament variations in *Austrostipa*. A – lemma and palea entirely glabrous (*A. lanata*, adaxial view) with hairy callus; B – lemma sparsely indumented with mostly non-overlapping hairs and scabrous shoulder region (*A. vickeryana*, lateral view); C – lemma and palea with overlapping hairs sparse enough to reveal underlying detail (*A. everettiana*); D – lemma and palea covered with hairs so dense that underlying detail is obscured, lemma and callus hairs are not differentiated, and shoulder region has a ‘shorn’ patch of hairs (*A. puberula*); E – photo of typical lemma and palea scraped clean of hairs showing smooth matte brown lignified surfaces undamaged by scraping (*A. everettiana*); F – tuberculate lemma surface where the glossy tubercles are fragile and shatter on scraping (*A. burgesiana*); G – schematic lemma shoulder section with continuous covering of even-length hairs; H – lemma shoulder section with scabrous patch that includes some normal-length hairs; I – lemma shoulder with clearly-defined patch of short ‘shaved’ hairs. Scale bar for florets is 5 mm, and for shoulder ornaments is 1 mm. Illustrations and images by the author based on *D.W. Goodall* 2705 (A); *W. O’Sullivan* WOS 303 (B); *A. Dooley* AD428 (C, E); *A.S. George* 10494 (D, I); *A.A. Mitchell & P.J. Waddell* 10499 (F); *A.M. Markey & J. Allen* 6267 (G); *K.R. Newbey* 11429 (H).

are essentially all the same, with no thickening at the base, nor any fragments of bulbous bases still adhering to them. In contrast, when the same scraping technique is applied to the lemma surface in subg. *Tuberculatae* it dramatically disrupts the tubercle bases. The lemma surface is left with ruptured tubercle bases all over the scraped surfaces, and the dislodged hairs are not all the same because at least some of them retain various amounts of tubercle fragments at their bases (see also Figure 18).

The same scraping technique can be used to distinguish between scabrous trichomes and the ‘shorn patch’ of hairs on the lemma shoulder in subg. *Eremophilae*. Normal lemma hairs grow up through the epidermis and are smoothly removed by the scalpel blade, leaving only the cut stub on an otherwise undamaged lemma surface, but scabrous trichomes are made of silica and have a broad thorn-like base attaching them to the lemma surface and the scraping technique disrupts these bases and leaves a scarred surface afterward.

Lemma surface indumentum especially requires clarification in distinguishing between the subgenera *Eremophilae* and *Lancea*, where the distinguishing feature is the presence or absence (respectively) of a short patch of ‘shorn’ hairs on the shoulder of the lemma. The definitions given in Vickery *et al.* (1986) and Jessop *et al.* (2006) are ambiguous and have two potentially different interpretations. In subg. *Eremophilae*, for example, the ‘shorn patch’ of shoulder hairs is said to be distinguished by an abrupt change in hair length, but it can also be ‘glabrous to scabrous’ in *A. puberula*. The glabrous state is potentially indistinguishable from a patch where hairs are merely ‘sparse’ as described for *A. mundula* and *A. flavescens* in subg. *Lancea* and the ‘scabrous’ and ‘shorn’ conditions could be difficult to distinguish from hairs that were merely ‘short’ compared to other parts of the lemma. Jessop *et al.* (2006) cited difficulty in separating subgenera *Eremophilae* and *Lancea* on their published descriptions, and in separating *A. eremophila* from *A. puberula* in size, and *A. eremophila* from *A. flavescens* regarding the lemma shoulder condition.

After an extensive examination of WA specimens in both subgenera, a distinctive separation between the two was formulated as follows:

- In subg. *Lancea*, the standard condition of the lemma is an even covering all over of long hairs (Figure 5G, note that *Austrostipa crinita* (Gaudich.) S.W.L.Jacobs & J.Everett has hairs of increasing length in the shoulder region which thereby create a ‘false coma’). In some species, and perhaps then only in some florets within a panicle, there may be a sparse patch near the lemma apex which exposes the lemma surface, and this is sometimes scabrous, where trichomes are usually ≤ 0.1 mm long, but it intergrades to at least some degree amongst the long hairs (Figure 5H).
- In subg. *Eremophilae*, every floret in the panicle bears a clearly defined ‘shaved’ or ‘short patch’ of hairs in the shoulder region below the apex. The short hairs are not sparse but of similar density to the surrounding longer hairs, and there is an abrupt and clear transition from long to short hairs around the edges of the patch (Figure 5I). This patch of hairs does not usually encircle the whole shoulder region but generally occupies only a limited dorsal portion on the abaxial side.

Some distinctive specimens of *A. eremophila* from the Nullarbor Plain have some unusual hairs that are inflated above their normal-sized bases, both in the ‘shaved’ shoulder region and in their coma. In the ‘shaved’ shoulder region some of these hairs look like tiny balloons, taking on the shape of a prolate spheroid because they are so short, and in some specimens, they lack pigment and are opaquely

white in contrast to the dark brown hairs on other parts of the lemma. And because they are attached to the lemma only by a standard-sized base they readily ‘pop’ off and fly away when scraped with the flat side of a scalpel blade. The hairs of the coma are also inflated to a similar diameter as those in the shaved region, but they are much longer and have the normal brown pigmentation and are translucent. The body hairs of the lemma in these specimens are otherwise typical of the genus, although unusually dark brown and distinctively shorter than in specimens found elsewhere. Furthermore, the lemma surface over the whole of the ‘shaved’ patch has a distinctive loss of pigmentation and appears whitish rather than dark brown. I chose not to recognize these characteristics as constituting a distinct taxon because I came across both specimens and individual florets that had intergrading characteristics. These specimens as a group are, however, worthy of further study.

Allocation of specimens into subgenera *Eremophilae* and *Lancea* can be difficult on other grounds, as Jessop *et al.* (2006) noted for some of their specimens from South Australia, so the multivariate study data on relevant members of both subgenera were combined, and the shoulder ornament states were scored as 0 = even or sparse hair covering, and 1 = distinctive shorn patch. Lemma hair differentiation was also scored as 0 = absent (e.g., no visible difference between the callus and lemma surface above it), and 1 = present (visible difference in hair presence, length, or orientation above the callus).

Cleistogamy

While Vickery *et al.* (1986) did not record the occurrence of the aberrant anther development syndrome and its consequent different-sized anthers, they did note that cleistogamous spikelets were commonly observed alongside chasmogamous spikelets within a single panicle, and that the cleistogamous spikelets usually had smaller anthers. *Austrostipa puberula* is usually cleistogamous, having three dwarfed and colourless anthers that are all fertile, while its near relative *A. eremophila* is chasmogamous and has three large, and fully fertile, pigmented anthers. Cleistogamy, colour loss, and aberrant anther maturation are probably independent developmental events, but they coincide in two of the new species (*A. turbinata* and *A. frankliniae* A.R. Williams).

Perennial grasses are usually chasmogamous, which maximizes their ability to spread their wind-borne pollen. Groves and Whalley (2002: 164) highlighted the role of cleistogamy as follows: ‘Self-fertilization retards gene flow between populations and facilitates spatial differentiation. ... Cleistogamy is, therefore, a mechanism for ensuring self-fertilization and the resulting high degree of structuring of genotypic frequency, increasing the frequency of genotypes adapted to local environments.’ The joint occurrence of cleistogamy, colour loss, and aberrant anther development suggests a unique adaptation to a particular local environment and thus a limited geographical range, which both of these species display.

One practical consequence of cleistogamy is that the anthers always remain inside the floret. As the spikelet matures, the anthers therefore become squashed up inside the lemma apex by the expanding caryopsis. In my experience, no cleistogamous floret has ever contained the squashed remnants of originally long and pigmented anthers; any squashed anthers have always been unpigmented (white in the dried condition, becoming translucent when rehydrated).

Since cleistogamy is the more unusual outcome in this combination of features it was scored as: 0 = absent; 1 = present; and non-overlapping lemma margins were not included as a separate character in multivariate analyses.

Sclerophyllous leaves

The Hughes (1921) revision of Australian *Stipa* included a study of leaf cross-section anatomy. While it was not found to reflect the perceived phylogenetic structure of the genus at the time, it did ‘add frequently to the distinctiveness of the species.’ One distinctive leaf type of interest in this study is the ‘sclerophyllous’ leaf. Hughes described it as having ‘a continuous sclerenchymatic hypoderma on both sides and strong percurrent girders, mesophyll much reduced.’ Morphologically it appears tightly rolled or folded, and the external (abaxial) surface is hard, rounded, stiff, smooth, and usually glabrous. In my experience, it only attains the fully indurate state at maturity, with some dried specimens containing younger leaves that have shrivelled, or (rarely) the blades may have been pushed outwards at the collar region by transiently swollen auricles. At maturity however, these auricles are resorbed, the ‘percurrent girders’ strengthened, and the leaf blades are back in the vertical position with the sheaths and blades permanently re-aligned, erect, hard, smooth and rounded.

Vickery *et al.* (1986) did not continue Hughes’ usage of this character, nor has it appeared in subsequent literature on *Austrostipa*, although it has important value in non-Australian *Stipa* as referenced here under the treatment of *A. subg. Lanterna* S.W.L.Jacobs & J.Everett. I also found it to be an extremely distinctive leaf type in the PERTH collections. It occurs in all species within *A. subg. Lobatae* S.W.L.Jacobs & J.Everett, and in all specimens of *A. pycnostachya* (Benth.) S.W.L.Jacobs & J.Everett, an endemic WA species in *A. subg. Falcatae* S.W.L.Jacobs & J.Everett. In the present study it occurs in both new species from the Ravensthorpe Ranges (*A. heteranthera*, *A. turbinata*), in the new record of *A. echinata*, and in *A. mundula* with its distinctively curved leaves. Vickery *et al.* (1986) distinguished *A. mundula* from *A. exilis* in having erect versus flexuose leaves, respectively, but this distinction is invalid because they failed to recognize leaf sclerophylly as a distinctive character, and they failed to recognize the smoothly curved single arc in the sclerophyllous leaves on the type specimen of *A. mundula* as a distinctive characteristic. The flexuose (wavy) leaf condition in *A. exilis* is due to its lack of sclerophyll so it is not restricted to the single-arc smooth curve seen in *A. mundula*.

Leaf sclerophylly was scored as 0 = absent, 1 = present in erect form, 2 = present in curved form, the latter distinction being justified on the grounds that linear sclerophyllous growth is mechanically simpler to achieve than smoothly integrated curved growth as observed in *A. mundula*.

Table 1. List of the 30 characters used in the multivariate study, with their scoring methods.

| Character | Units or States |
|---------------------------------------|--|
| Habit | 0 = densely packed erect culms; 1 = open tussock |
| Culm height (including inflorescence) | mm |
| Culm width above the base | mm |
| Basal leaf sheath width | mm |
| Leaf blade length | mm |
| Leaf blade width (dry specimens) | mm |
| Leaf blade abaxial indumentum | 0 = absent, sparse, or rare; 1 = well developed & common |
| Leaf blade sclerophylly | 0 = absent; 1 = present, erect; 2 = present, curved |
| Panicle length | mm |
| Lower glume length | mm |
| Upper glume length | mm |

| Character | Units or States |
|--------------------------------|---|
| Lemma length | mm |
| Lemma hair density | 1 = sparse, exposing the palea; 2 = dense, concealing the palea and lemma surface |
| Lemma hair colour at maturity | 0 = white; 1 = various shades of brown |
| Lemma hair length | 0 = undifferentiated; 1 = differentiated at callus |
| Lemma shoulder characteristics | 0 = sparse or evenly indumented; 1 = distinctly 'shaved' |
| Palea margins | 0 = matte; 1 = glossy |
| Cleistogamy | 0 = absent; 1 = present |
| Callus length | mm |
| Awn length | mm |
| Column length | mm |
| Column length to 1st bend | mm |
| Column width above the base | mm |
| Column hair length | mm |
| Longest anther length | mm |
| Shortest anther length | mm |
| Short anther fertile | 0 = no; 1 = yes |
| Anther colour | 0 = not pigmented; 1 = opaquely pigmented |
| Long anther penicillation | 0 = none; 1 = few to many |
| Caryopsis length | mm |

Taxonomy

Jacobs and Everett (1996) divided the genus into thirteen subgenera, eleven of which contain WA species. Several attempts have been made to critically assess this subgenus structure using molecular sequences, chromosome numbers, and micro- as well as macro-morphological data. Bustam (2010) concluded that her molecular and micro-morphological data did not 'contain enough information for analyses at subgeneric level.' Syme *et al.* (2012) suggested from analyses of nuclear ribosomal ITS sequences that subg. *Eremophilae* should perhaps be included in subg. *Austrostipa*. Another study by Syme (2012) showed strong phylogenetic support for recognizing subgenera *Austrostipa*, *Falcatae*, and *Lobatae*, and strong support for joining *Bambusina* and *Petaurista*, while other subgenera including *Eremophilae* had mixed phylogenetic origins (*Lancea* was not represented).

Winterfeld *et al.* (2015) used cytogenetic data mapped onto molecular phylogenetic trees based on nuclear ITS and chloroplast 3' *trnK* DNA sequence data and found widespread polyploidy and hybrid speciation as well as evidence of parapatry in the genus. They found four 'strongly supported' lineages within *Austrostipa*: Clade 1 (subg. *Lobatae*), Clade 2 (subg. *Falcatae*), Clade 3 (subg. *Arbuscula*, *Bambusina*, and *Petaurista*), and Clade 4 (subg. *Austrostipa*, *Ceres*, *Lancea*, *Tuberculatae*). They concluded, however, that the cytogenetics of *Austrostipa* is evolutionarily still unstable and much more work is required.

Tkach *et al.* (2021) used molecular phylogenetics, micromorphology and cytogenetic data and likewise found clear evidence of hybrid speciation and polyploidy within *Austrostipa*. Their analyses did not clearly support the monophyly of the genus and they tentatively suggested the inclusion of subgenera *Ceres*, *Eremophilae*, *Lancea*, *Lanterna*, and *Tuberculatae* into an expanded *Austrostipa* subgenus with the following qualification: ‘This suggestion, however, should not be interpreted as attempt to supersede traditional morphology-based by molecular phylogenetic taxonomic concepts. It is rather a contribution to obtain monophyletic taxa, which can serve as reliable units addressing questions about character evolution and/or biogeography in *Austrostipa*, which have been barely touched upon to date.’ They also erected a new monospecific subgenus on their evidence (*Austrostipa* subg. *Paucispiculatae* Röser, Tkach & M.Nobis), with the type species *A. muelleri* (Tate) S.W.L.Jacobs & J.Everett. This species does not occur in WA.

The crucial issue in alpha taxonomy, which is the concern of this present study, is to know which morphological characters provide the best indicators of historical diversification, so hypotheses about historical diversification can legitimately be used to suggest which might be such morphological indicators. If we accept the four ‘strongly supported’ clades of Winterfeld *et al.* (2015) and include subg. *Eremophilae* and *Lanterna* in Clade 4 as suggested by Tkach *et al.* (2021) then we could reduce the number of subgenera in WA to five as follows:

ARBUSCULA (*Arbuscula*, *Bambusina*, *Petaurista*) – this group highlights the combination of branching culms and robustly rhizomatous root systems.

AUSTROSTIPA (*Austrostipa*, *Ceres*, *Eremophilae*, *Lancea*, *Lanterna*, *Tuberculatae*) – this group brings together the perennial, caespitose, herbaceous habits, with twice bent awn columns, and mostly non-saline habitats.

FALCATAE – this group highlights the role of awn shape differences (falcate versus twice bent).

LOBATAE – this group highlights the move to saline habitats (endemic to south-west WA only) and the associated development of a rush-like habit in culms, leaves, and tillers.

LONGIARISTATAE – this group highlights the annual versus perennial habit.

Would such an arrangement add anything of substance to our understanding of the genus? It is simpler, and thus easier to comprehend as a possible reflection of the historical diversification of the genus, and it does suggest ways in which future studies might be able to find causal links, or at least correlations between, the molecular/chromosomal data and the morphological data. However, all authors acknowledged uncertainty in their conclusions, significant methodological criticism exists (e.g. Alvarez & Wendel 2003; Krawczyk *et al.* 2017), and this annotated list is nothing more than my personal *post hoc* attempt to rationalize their results. Much more research is yet required to produce a definitive result. Nevertheless, as an interim guide for the benefit of future research I have included a key to these newly suggested subgenera below, and the main key to the species is arranged according to the same subgenus structure.

In the case of the separation of *A. anaiwaniorum* A.R. Williams from *A. tenuifolia* (Steud.) S.W.L.Jacobs & J.Everett, a re-circumscription of *A. tenuifolia* is given. New and revised descriptions of both *A. vickeryana* and *A. lanata* are given because many new collections have become available since

the original descriptions were formulated and because of the reduction of *A. nullanulla* to synonymy with *A. vickeryana*.

Key to a revised subgenus structure among *Austrostipa* in WA

1. Culms of mature plants usually branched at the nodes; nodes and auricles usually glabrous, ligules > 1 mm long, glabrous; nodes exerted well above the lower leaf sheaths; mature root system robustly rhizomatous; panicle branches glabrous, scabrous, or conspicuously hairy and may be strongly divergent from the panicle axis; awns straight or once bent at maturity, or weakly falcate (if strongly falcate then the bristle is conspicuously flattened)..... subg. **ARBUSCULA**
- 1: Culms of mature plants unbranched at the nodes; auricles often hairy, ligules < 1 mm long (except *A. pycnostachya*); nodes glabrous to densely sericeous, often concealed by the leaf sheath from a lower node; mature root system caespitose; panicle branches glabrous or scabrous, not strongly divergent from the panicle axis; awns twice bent or falcate at maturity
 2. Awn column straight, bristle clearly falcate; lemma hairs white at maturity (reddish-brown in *A. frankliniae*) 2. subg. **FALCATAE**
 - 2: Awn column twice bent, bristle straight; lemma hairs white, or turning brown at maturity
 3. Plants annual; tussocks of a single flowering culm which has a long, broad, flag leaf fully sheathing the base of the much longer inflorescence, together with a basal tuft of short, narrow tillers; awns unusually long, mostly > 100 mm, (often appears only after fire) subg. **LONGIARISTATAE**
 - 3: Plants perennial; tussocks with one or more flowering culms, which are usually much longer than the inflorescence; awns clearly twice bent & usually < 70 mm long
 4. Plants salt-tolerant, found around salt lakes or in salinized seasonally flooded areas; tussocks with long, erect, terete leaves, similar to and difficult to distinguish from the flowering culms; the most common species (*A. juncifolia*) has long, translucent, hairy lemma lobes subg. **LOBATAE**
 - 4: Plants not salt-tolerant; tussocks usually with a basal tuft of leaves that are easily distinguished from the erect flowering culms; lemma lobes short or absent 1. subg. **AUSTROSTIPA**

Key to the species and subgenera of *Austrostipa* in Western Australia

* indicates species that are keyed twice.

1. Culms of mature plants usually branched at the nodes; nodes and auricles usually glabrous, ligules > 1 mm long, glabrous; nodes exerted well above the lower leaf sheaths; mature root system robustly rhizomatous; panicle branches glabrous, scabrous, or conspicuously hairy and sometimes strongly divergent from the panicle axis; awns straight or once bent at maturity, or weakly falcate (if strongly falcate then the bristle is conspicuously flattened)..... subg. **ARBUSCULA**
2. Florets, with straight or weakly bent awns, remaining attached to the glumes at maturity, the widely divergent panicle branches creating an orb-like structure which breaks off from the culm at maturity so the whole panicle acts as the dispersal unit and blows around in the wind; panicle branches

- conspicuously hairy, the hairs erect and 0.3–3.0 mm long; lemmas glabrous, scabrid, and minutely tuberculate, with a short and angled callus
3. Pedicel hairs 1–3 mm long; culms and leaves mostly glabrous; occurs widely across the Southwest and into the arid zone **A. elegantissima**
 - 3: Pedicel hairs 0.3–1.0 mm long; lower culms and leaves densely pubescent; restricted to arid parts of the Southwest **A. tuckeri**
 - 2: Florets disarticulating from the glumes at maturity, the awns usually falcate; panicle branches glabrous or scabrous with hairs ≤ 0.3 mm long; lemmas densely hairy, callus weakly bent
 4. Lemmas 3–4 mm long awns 14–30 mm long, lower glume 4–5.5 mm long (restricted to the Nullarbor Plain on skeletal sandy soils)..... **A. nullaborensis**
 - 4: Lemmas 4.5–6.5 mm long, awns 30–90 mm long, lower glume 6–15 mm long
 5. Awn bristle strongly curved and distinctly flattened, wider than the column which is scabrous **A. platychaeta**
 - 5: Awn bristle slightly curved or straight, not flattened, and no wider than the column which is usually pubescent **A. acrociliata**
 - 1: Culms of mature plants unbranched at the nodes; auricles often hairy, ligules < 1 mm long (except *A. pycnostachya*); nodes glabrous to densely sericeous, often concealed by the leaf sheath from a lower node; mature root system caespitose; panicle branches glabrous or scabrous, not strongly divergent from the panicle axis; awns twice bent or falcate at maturity
 6. Awn column straight, bristle clearly falcate; lemma hairs white at maturity (reddish-brown in *A. frankliniae*) subg. **FALCATAE**
 7. Culm bases, nodes, sheaths, and leaf blades densely hairy
 8. Lemma hairs white; leaves straight, curved or flexuose but not curled into circles; culm bases not swollen, hairs straight
 9. Leaves coarse, stiff, erect, or gently curved; column pubescent, hairs 0.3–1.5 mm long..... **A. drummondii**
 - 9: Leaves flexuose; column scaberulous, hairs < 0.3 mm long..... **12. A. nunaginisensis**
 - 8: Lemma hairs brown; leaf blades stiffly curled backwards into circular patterns; culm bases swollen and densely covered in long crinkled hairs..... **11. A. frankliniae**
 - 7: Culm bases, nodes, sheaths and leaves mostly glabrous or sparsely hairy
 10. Culms from a short rhizome; nodes hairy; ligules 3–7 mm long; leaf blades narrow, terete, smooth, erect, and glabrous; panicle dense, compact and spike-like, up to 140 mm long, 10 mm wide, enclosed by sheath; column hairs 0.02–0.05 mm long **A. pycnostachya**
 - 10: Culms from a tussock; nodes usually glabrous; ligules usually < 1 mm long; leaf blades not simultaneously terete, smooth, erect and glabrous; panicle somewhat spreading, not spike-like, 250–400 mm long; column hairs usually > 0.05 mm long
 11. Spikelets large in most parts: lower glume 14–20 mm long, upper glume 11.5–18 mm long; floret 7–8 mm long; awn 70–100 mm long, sturdy (0.3–0.4 mm wide near the base), bristle strongly falcate

12. Auricles small or absent; ligule densely hairy abaxially; awn column weakly twice bent **13. *A. tenuifolia***
12. Auricles prominent, with a dense line of long broad hairs underneath; ligule glabrous; awn column straight, **10. *A. anaiwaniorum***
- 11: Spikelets small in most parts: lower glume 8–14 mm long, upper glume 6–12.5 mm long; floret 4–6.5(–7) mm long; awn 38–90 mm long, delicate (usually 0.2–0.3 mm wide near the base), bristle gently falcate
13. Leaf blades very fine 0.3–0.6(1.2) mm wide, inrolled, ribbed; nodes exerted, glabrous
14. Tussock open at base, culms at angles to one another, not erect; leaf sheaths green, loose around the culm, softly pilose; blades with dense, erect, long (≥ 0.5 mm) spreading hairs; column ≤ 10 mm to the first bend, pubescent with hairs ≥ 0.25 mm long ***A. trichophylla***
- 14: Tussock densely packed, culms erect; leaf sheaths glabrous, long and tightly clasping the culms; blades glabrous, scabrous or shortly pubescent, hairs < 0.5 mm long; column 2.5–7 mm to the first bend, scabrous with hairs ≤ 0.2 mm long ***A. scabra***
- 13: Leaf blades 1–3 mm wide, often expanded and flexuose; nodes may be concealed by subtending leaf sheath, glabrous
15. Nodes of culm exposed; awn column scabrous or pubescent, hairs usually ≥ 0.2 mm long
16. Plants slender, culms compressible, ≤ 1 mm wide, tillering intravaginally; lemma surface finely granular, becoming coarser near the apex where the white hairs are sparse, awn column densely pubescent or villous with erect hairs 0.2–0.5 mm long ***A. variabilis***
- 16: Plants robust, culms not compressible, 1–2 mm wide, tillering extravaginally but caespitose; lemma surface smooth or slightly granular, entirely sericeous; awn column scabrous ***A. nodosa***
- 15: Nodes of culm concealed by subtending leaf sheaths; awn column minutely scabrous, hairs < 0.05 mm long ***A. nitida***
- 6: Awn column twice bent, bristle straight; lemma hairs white, or turning brown at maturity
17. Plants annual, often appearing only after fire; tussocks with a single flowering culm which has a long, broad, flag leaf fully sheathing the base of the much longer inflorescence, together with a basal tuft of short, narrow tillers; awns unusually long, mostly > 100 mm subg. **LONGIARISTATAE**
18. Leaf sheaths covered with distinctively large, broad, long, transparent hairs, sometimes only on the lower sheaths ***A. macalpinei***
- 18: Leaf sheaths glabrous or minutely scabrous, sometimes with a few distinctively large, broad, long, transparent hairs on some sheath margins only ***A. compressa***
- 17: Plants perennial; tussocks with one or more flowering culms, which are usually much longer than the inflorescence; awns clearly twice bent & usually < 70 mm long

19. Plants found around salt lakes or in salinized seasonally flooded areas; tussocks with long, erect, terete leaves, similar to and difficult to distinguish from the flowering culms; the most common species (*A. juncifolia*) has long, translucent, hairy lemma lobes subg. **LOBATAE**
- 20: Basal leaf sheaths 7–14 mm wide; ligule 2.5–12 mm long, smoothly integrated with the sheath so there are no sheath lobes; lemma lobes 1–3 mm long; growing around salt lakes or salinized soils in the southern Wheatbelt in Western Australia
21. Upper glumes 9–10 mm long; floret 6.5–9 mm long; callus 1.1–1.5 mm long; lemma lobes 1–2.5 mm long; awn 25–50 mm long; anthers penicillate; style glabrous (widespread in Southern Wheatbelt) **A. juncifolia**
- 21: Upper glumes 12–16 mm long; floret 9–12 mm long; callus 2–3 mm long; lemma lobes 2.5–3 mm long; awn 50–80 mm long; anthers not penicillate; style hispid with bristly hairs 0.2–0.4 mm long (known only from Lakes King, Grace, Tay and Chinocup) **A. geoffreyi**
- 20: Basal leaf sheaths 2–4 mm wide; ligule 0.0–1.0(–2) mm long, usually shorter than adjacent sheath lobes; lemma lobes 0.4–1.0 mm long; growing on the Swan Coastal Plain in seasonally flooded calcareous soils
22. Ligule broad between short sheath lobes; involucre a glabrous ridge of indurated tissue at the base of the panicle, not encircling the culm; upper glume 5-nerved in the lower part; lemma hairs white at maturity; anthers not penicillate, 3.2–3.3 mm long. **A. jacobsoniana**
- 22: Ligule narrow to almost absent between long sheath lobes (2–6 mm); involucre a ring of hairs 0.3–1.3 mm long at the base of the panicle that almost encircle the culm; upper glume 3-nerved in the lower part; lemma hairs dark golden brown at maturity; anthers penicillate, 4.2–5 mm long **A. bronwenae**
- 19: Plants not found in saline habitats; tussocks usually with a basal tuft of leaves that are easily distinguished from the erect flowering culms; lemma lobes short or absent
23. Lemma hairs white at maturity
24. Awn column with conspicuously long hairs 0.5–5 mm long throughout its length, sometimes extending along one side of the bristle subg. **AUSTROSTIPA**
25. Awn column 17–30 mm to the first bend, the hairs 0.3–2.0 mm long, evenly distributed and not extending along the bristle; lemma 7–13 mm long
26. Lemma 8–13 mm long; column 20–30 mm to the first bend; awn 70–110 mm long; leaf blades and sheaths glabrous or scabrous; upper glume 6-nerved in the lower part **A. semibarbata**
- 26: Lemma 7–10 mm long; column 17–24 mm to the first bend; awn 50–70 mm long; leaf blades and sheaths hairy; upper glume 1–4-nerved in the lower part **A. campylachne**
- 25: Awn column 5–17 mm to the first bend, the hairs 0.5–5.0 mm long, often attached to only one side of the column making a spiral pattern which sometimes extends along one side of the bristle; lemma 4–11.5 mm long
27. Lemma 4–7.5 mm long; column 5–15 mm to the first bend, the hairs 0.5–5.0 mm long; awn 30–60 mm long; upper glume 10–16 mm long; culm base glabrous or scabrous **A. hemipogon**

- 27: Lemma 7.5–11.5 mm long; column 10–17 mm to the first bend, the hairs 0.6–3.0 mm long; awn 60–100 mm long; upper glume 15–20 mm long; culm base hairy **A. mollis**
- 24: Awn column hairs rarely exceeding 0.3 mm long, bristle scabrous
- 28: Lemma with a true coma of long hairs, 2–5 mm long, which all emerge from around the lemma apex, and at seed-fall the hairs diverge umbrella-like; inland plants..... **A. blackii**
- 28: Lemma *either* with a long false coma where the lemma hairs are distributed evenly but increase in length towards the apex and at seed-fall the hairs remaining appressed to the lemma; *or* with no coma, or a true coma ≤ 0.5 mm long
- 29: Floret with long white hairs in a false coma, 2–2.5 mm long; lemma hairs gradually increasing in length towards the apex; on the mid-west coast only, and nearby islands..... **A. crinita***
- 29: Floret either with no coma, or a true coma ≤ 0.5 mm, the hairs white or slightly coloured; lemma hairs evenly short, scabrous, or absent; in the south-west and southern coastal and inland regions
- 30: Foliage bluish, densely covered with short velvety hairs ≤ 0.1 mm long; coast and islands of the Great Australian Bight only **A. velutina***
- 30: Foliage green, either glabrous, scabrous, or with hairs up to 0.5 mm long and sparse enough to be seen individually, and generally of uneven lengths, not velvety; widespread in the agricultural region **4. A. exilis***
- 23: Lemma hairs various shades of brown at maturity
- 31: Lemma surface smooth and sometimes shiny but not glossy, entirely glabrous (except for the callus), or with few sparse hairs; the leaf sheath margins, auricles and ligules bearing very long (up to 9 mm) and crinkly-woolly hairs
- 32: Lower glume 15–26 mm long; ligules 0.4–1.5 mm long; lemma and palea usually entirely glabrous, palea fully or at least clearly exposed at maturity **7. A. lanata**
- 32: Lower glume 9–18 mm long; at least some ligules $>> 2$ mm long; lemma and palea sparsely hairy (rarely both glabrous), palea fully and firmly enclosed by lemma throughout development..... **8. A. vickeryana**
- 31: Lemma surface mostly smooth (glossy and rough in *A. burgesiana*), usually evenly covered with hairs but sometimes with a distinctive patch in the shoulder region either glabrous, scabrous, or with sparse or evenly ‘shorn’ hairs; leaf sheath margins, auricles and ligules with straight hairs usually ≤ 1 mm
- 33: Lemma surface glossy and rough (tuberculate) due to silica bodies that shatter when scraped with the edge of a scalpel blade..... **9. A. burgesiana**
- 33: Lemma surface hard and mostly smooth, not overall tuberculate, not glossy, with hairs that may be cleanly removed with a scalpel blade without damaging the surface
- 34: Lemma hairs either dark brown at maturity with an evenly ‘shorn’ patch of short hairs on the shoulder region just below the apex or (in *A. plumigera*) pale brown and with long hairs (0.5–1 mm long) on both sides of the awn bristle

35. Flowering culms short and narrow, usually ≤ 1 mm wide and ≤ 60 cm tall, erect and densely packed, often indistinguishable from tillers; basal leaf sheaths similar in diameter to tiller and usually ≤ 1 mm wide; mature leaves narrow, indurate, and terete
36. Lemma hairs sparse enough to reveal the drawn-back lemma margins, which broadly expose the palea; at maturity, the palea margins brightly glossy **1. *A. everettiana***
36. Lemma hairs dense enough to obscure the state of the lemma margins and the palea; at maturity, the palea margins not glossy **3. *A. turbinata***
35. Flowering culms broader than tillers and usually ≥ 2 mm wide, 80–120 cm tall, spreading and/or geniculate, not densely packed; basal leaf sheaths loosely clasping (tightly clasping in *A. koordana*) or peeling away from the culm shortly above the base, larger than tiller sheaths; mature leaves not indurate or terete, either revolute or flat, usually with a distinct and enduring auricle and the blade arising at an angle to the culm
37. Bristle on the awn with long hairs (0.5–1.0 mm) on both sides ***A. plumigera***
37. Bristle on the awn scabrous, with hairs < 0.2 mm on both sides
38. Anthers ≤ 2 mm long, unpigmented, all or only one fertile, and at maturity remaining compressed within the cleistogamous floret; lower glume 8–14 mm long
39. Anthers all fertile, equal lengths, 1–2 mm long; lemma surface smooth; callus 0.7–1.8 mm long; panicle regular in size & shape (pyramidal); leaf sheaths ≤ 100 mm long, not tightly stem-clasping; ligule inconspicuous ***A. puberula***
39. Anterior anther ~ 1 mm long and fertile, posterior ones 0.4–0.5 mm long, sterile; lemma surface smoothly rugose; callus 2–2.6 mm long; panicle irregular (not pyramidal), sparse with long internodes (~ 80 mm) and few spikelets at the lower nodes clustered on branches very much shorter (~ 15 mm) than the internodes; leaf sheaths 200–300 mm long, tightly stem-clasping; ligule visible and densely pubescent with conspicuous white hairs **2. *A. koordana***
38. Anthers ≥ 2.5 mm long, always pigmented and fertile; floret chasmogamous; lower glume 15–25 mm long ***A. eremophila***
34. Lemma hairs variously pale brown through to dark brown at maturity, sometimes with a glabrous or scabrous bare patch in the shoulder region, sometimes with scattered longer hairs, but not having an evenly ‘shorn’ patch
40. Awn column with long hairs near the base, grading to short hairs where it meets the bristle; restricted to dongas (gilgais) on the Nullarbor Plain ***A. dongicola***
40. Awn column with evenly distributed hair lengths throughout; mostly coastal plants, but also inland in the Wheatbelt region
41. Leaves rigidly erect and pungent-pointed; awn 90–110 mm long, column 30–35 mm long ***A. echinata***
41. Leaves erect or flexuose, not pungent-pointed; awn 23–80 mm long, column ≥ 30 mm long
42. Floret with long white hairs in a false coma, 2–2.5 mm long; lemma hairs gradually increasing in length towards the apex; on the mid-west coast only, and nearby islands ***A. crinita****

- 42: Floret either with no coma, or a short coma, the hairs white or coloured; lemma hairs evenly short, scabrous, or absent; in the south-west and southern coastal and inland regions
- 43: Foliage bluish, densely covered with short velvety hairs ≤ 0.1 mm long; coast and islands of the Great Australian Bight only **A. *velutina****
- 43: Foliage green, either glabrous, scabrous, or with hairs up to 0.5 mm long and sparse enough to be seen individually, and generally of uneven lengths, not velvety; usually found further into the South-West region
- 44: Flowering culms short and narrow, usually ≤ 1 mm wide and ≤ 60 cm tall, often indistinguishable from innovations and erect and densely packed; basal leaf sheaths similar in diameter to tiller basal sheaths and usually ≤ 1 mm wide; mature leaves narrow and sometimes flexuous, or indurate and either terete and erect or stiffly curved
- 45: Leaf sheaths and blades usually hirsute with long hairs exceeding 0.5 mm and shorter hairs of various lengths between them, blades flexuous; lemma hairs white at maturity **4. A. *exilis****
- 45: Leaf sheaths and blades glabrous or pubescent (hairs < 0.5 mm); lemma with brown hairs at maturity
- 46: Anthers translucent white when re-hydrated, of different sizes, one fertile and 0.8–1.1 mm long, two sterile and 0.4–0.6 mm long **5. A. *heteranthera***
- 46: Anthers opaquely pigmented, all fertile and 3–4 mm long **6. A. *mundula***
- 44: Flowering culms broader than innovations and usually ≥ 2 mm wide, spreading and/or geniculate, not densely packed, 80–120 cm tall; basal leaf sheaths loosely clasping or peeling away from the culm shortly above the base, larger than tiller sheaths; mature leaves not indurate or terete, either revolute or flat, usually with a distinct and enduring auricle and the blade arising at an angle to the culm **A. *flavescens***

1. *Austrostipa* S.W.L.Jacobs & J.Everett subg. *Austrostipa*

A. *Eremophilae* group (previously *Austrostipa* subg. *Eremophilae* S.W.L.Jacobs & J.Everett)

A number of unusual specimens were collected during vegetation mapping (Craig *et al.* 2008) and floristic surveys (Kern *et al.* 2008; Markey *et al.* 2012) of the Ravensthorpe Ranges in the southern region of the Yilgarn Greenstone Belt (Bodorkos & Sandiford 2006) which did not fit descriptions for existing species recorded for WA but they did match *A. mundula* (*Lancea* group), using the text keys in Jessop *et al.* (2006) and Everett *et al.* (2009). This species had previously been recorded only in south-east South Australia and western Victoria. However, the new specimens differed from *A. mundula* in some major characters not used in the text keys. Two new interim taxa were identified amongst them and were entered into the WA plant census (<https://florabase.dpaw.wa.gov.au>) as *Austrostipa* sp. Ravensthorpe Range (A. Markey & J. Allen 6261) described here as *A. heteranthera*, and *Austrostipa* sp. Carlingup Road (S. Kern & R. Jasper LCH 18459) described here as *A. turbinata*.

While searching the PERTH collection for specimens of *A. flavescens* similar to the Ravensthorpe Ranges material, a number of specimens turned out to closely match *A. mundula* but with just two minor differences in non-key characters. These collections were from several isolated pockets around the south and west coast that had geographical disjunctions of up to 2,500 kilometres from their nearest relatives in South Australia, so they were entered into the WA plant census with the interim phrase name *Austrostipa mundula* subsp. *Torndirrup* (C.A. Hortin 1068) although this subspecies status was subsequently rejected (see below).

A floristic survey of the Forrestania Greenstone Belt in the Mt Holland area in October 2009 (Thompson & Allen 2013) yielded another unusual but immature specimen of *Austrostipa* that was entered into the WA plant census as *Austrostipa* sp. Mt Holland (W.A. Thompson & J. Allen 948). Further survey work in October 2012 relocated the population of about 50 scattered tussocks, from which mature specimens were collected. Extensive searching for other populations in nearby localities was carried out (Andrew Dooley field notes Oct. 2012). Several populations of *A. puberula* (*Eremophilae* group of subg. *Austrostipa*) were located nearby. Thompson and Allen (2013) found immature specimens of *Austrostipa* sp. Carlingup Road (S. Kern & R. Jasper LCH 18459) about 8 km to the north on the Forrestania Greenstone ridge but no additional populations of *A. sp.* Mt Holland. This taxon is in clear need of priority conservation because the Forrestania Greenstone Belt has no conserved areas within it (Thompson & Allen 2013) and it is being actively mined and explored for base and precious metals. *Austrostipa* sp. Mt Holland (W.A. Thompson & J. Allen 948) is described here as *A. everettiana*.

The two new Ravensthorpe Ranges taxa had floral characteristics distinctive of the *Lancea* and *Eremophilae* groups, and were uniformly small in all parts, yet not so small as to rule out falling within the extreme lower limits of other known species and subspecies. To investigate this possibility, all specimens of potentially related species (*A. flavescens* and *A. exilis* from *Lancea*, and *A. eremophila* and *A. puberula* from *Eremophilae*) in the PERTH collection were examined, plus representative loan specimens from AD of *A. mundula* (including the holotype), *A. eremophila*, *A. flavescens*, *A. exilis* plus several specimens with '*A. exilis*?' as the identification. A list of potentially important characters was compiled from published keys, together with two-way comparisons among each of the listed species using the DELTA dataset derived from Vickery *et al.* (1986) adjusted to reflect character data observed in PERTH collections and the final list of 30 characters used is presented in Table 1.

A number of multivariate analyses were then carried out using these 30 characters scored with averaged published values for each of the existing species, plus individual specimen values for the new species and *A. mundula* and *A. puberula* (the published species with characteristics most similar to the new taxa). An ordination plot of results is given in Figure 6 which clearly shows that the new species are quite distinct from existing species. In the cases of both *A. puberula* and *A. mundula*, all the specimens from WA grouped most closely with the averaged values from their published data.

Figure 6 shows that the variation between specimens is usually much less than the variation between taxa. *Austrostipa turbinata* and *A. heteranthera* are distinct from one another, *A. everettiana* is unique, and the WA collections of *A. mundula* group most closely with its averaged published range data.

The characters that distinguish the three new species in the *Eremophilae* group (*A. turbinata*, *A. koordana*, and *A. everettiana*) from likely relatives are given in Table 2.

Table 2. Differences between new and allied species in *Eremophilae* group of *Austrostipa* subg. *Austrostipa*.

| Character | Species | | | | |
|-----------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|
| | <i>A. everettiana</i> | <i>A. puberula</i> | <i>A. eremophila</i> | <i>A. koordana</i> | <i>A. turbinata</i> |
| Culms | narrow, densely packed, erect | broad, in an open tussock, geniculate | broad, in an open tussock, geniculate | broad, in an open tussock, geniculate | narrow, densely packed, erect |
| Leaf sheaths | 0.5–0.9 mm wide, glabrous margins | 5–7 mm wide, woolly margins | 4–8 mm wide, ciliate margins | 3 mm wide, glabrous margins | 1.0–1.3 mm wide, glabrous margins |
| Leaf blades | 3.5–12 cm long, 0.3 mm wide | 10–25 cm long, 1–2 mm wide | 10–30 cm long, 1.5–4 mm wide | 21–28 cm long, 0.7–1.2 mm wide | 4–17 cm long, 0.3–0.6 mm wide |
| Panicle | 6–10 cm long | 15–30 cm long | 15–30 cm long | 22 cm long | 9–16 cm long |
| Lower glumes | 10–12 mm long | 8–14 mm long | 15–25 mm long | 12–14 mm long | 12–16 mm long |
| Lemma hair appearance | differing from callus | same as callus | differing from callus | same as callus | same as callus |
| Lemma indumentum | sparse, revealing the uncovered palea | dense, concealing the uncovered palea | dense, concealing the uncovered palea | dense, concealing the uncovered palea | dense, concealing the uncovered palea |
| Exposed palea margins | glossy, glabrous | dull, with hairs | dull, with hairs | dull, with hairs | dull, with hairs |
| Anthers | 2–2.3 mm long, not penicillate | 0.6–2 mm long, penicillate | 2.5–4 mm long, penicillate | 0.4–1.0 mm long, not penicillate | 0.3–1.6 mm long, penicillate |
| Caryopsis | 2.6–2.9 mm long | 2–5 mm long | 3.5–4.5 mm long | 2.7–3 mm long (immature) | 2.2–2.5 mm long |

1. *Austrostipa everettiana* A.R. Williams, *sp. nov.*

Typus: Forrestania Greenstone Belt, Mt Holland area, Western Australia [precise locality withheld for conservation reasons], 27 October 2012, *A. Dooley* AD428 (*holo*: PERTH 08414297; *iso*: CANB).

Austrostipa sp. Mt Holland (W.A. Thompson & J. Allen 948), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 12 July 2021].

Perennial *grass*, with densely packed, erect, narrow culms arising from a short rhizome; shoots intra- or extra-vaginal, 400–600 mm tall, with a basal tuft of leaves. *Culms* unbranched, not geniculate, glabrous; nodes two per culm, exserted, thickened, with abundant retrorse indumentum. *Leaf sheaths* tightly enveloping the culm, 0.7–0.9 mm wide at the base of the culm, 0.5–0.9 mm wide at the upper nodes, glabrous. *Ligules* 0.3–0.5 mm long, blunt; abaxial surface and margin sericeous with hairs 0.5–0.7 mm long; adaxial surface glabrous; sheath lobes absent. *Auricles* distinct and subtended by erect hairs 1.7–2.3 mm long. *Leaf blades* green at flowering time, flexuose, 35–120 mm long, *c.* 0.3 mm

wide in the inrolled or involute state; abaxial surface ribbed and scabrous; adaxial surface strongly ribbed and scaberulous with minute scattered trichomes. *Panicle* 60–100 mm long, exserted, narrowly contracted, 10–25 mm wide, not subtended by a marked involucre, the spikelets overlapping; lowest internodes 15–30 mm long, scaberulous, the hairs 0.01–0.03 mm long; minimum undivided branch length 4–6 mm, maximum undivided branch length 6–10 mm; branches with acutely angled edges, 20–25 mm long including glumes; pedicels angular, 2–12 mm long, scabrous on their edges, the hairs 0.05–0.2 mm long. *Spikelets* 10–12 mm long, 3–9 per node. *Glumes* subequal, acuminate, scabrous on nerves, straw-coloured; lower glume 3-nerved, 10–12 mm long; upper glume 5-nerved, 9–10 mm long. *Floret* turbinate, 4.3–6.0 mm long, sericeous with an even covering of initially white hairs that turn rich brown at maturity, 0.4–0.8 mm long, with a distinct ‘shorn’ patch of short hairs near the apex. *Lemma* hairs sparse enough during development to expose the palea, at maturity the glossy palea margins also visible; lemma lobes inconspicuous, 0.07–0.2 mm long; lemma margins drawn back to reveal the palea, which has glossy glabrous margins at maturity and a dorsal line of hairs equal in length to those on the lemma; *coma* distinct, 1.1–1.5 mm long. *Callus* 2.0–2.9 mm long, sericeous with rich brown hairs 0.5–0.7 mm long, the tip weakly bent. *Awn* 37–44 mm long, 0.35–0.45 mm wide near the base, twice bent; column 15–20 mm long, 7–11 mm to the first bend, scabrous with hairs 0.2–0.3 mm long; bristle straight, angular in cross section, no broader than the column, scaberulous with hairs *c.* 0.01 mm long. *Palea* subequal to the lemma. *Lodicules* not seen. *Anthems* 3, all fertile, brown, 2.0–2.2 mm long, not penicillate. *Style* glabrous. *Caryopsis* 2.6–2.9 mm long, 0.2 mm wide; embryo 0.7–1.0 mm long; hilum 1.5–2.0 mm long. (Figure 7A–C)

Diagnostic features. Extremely narrow erect culms in densely packed tussocks; twice-bent awn column with straight bristle; dark brown indumentum on mature floret with short patch of ‘shaved’ hairs on the shoulder region; immature lemma margins drawn back to fully expose the palea underneath, and mature florets clearly revealing the exposed palea to have a narrow band of dorsal hairs and glossy, glabrous margins.

Other specimens examined. WESTERN AUSTRALIA: [locality withheld for conservation reasons] 2 Oct. 2009, W.A. Thompson & J. Allen 948 (PERTH).

Phenology. Flowers September–October with fruit maturing in October–November.

Distribution and habitat. Only known from one location (Figure 7D) in the Southern Cross sub-bioregion of the Coolgardie bioregion, where it grows in low, open *Eucalyptus* woodland over a sparse shrubland of *Melaleuca*, *Acacia*, *Santalum* and *Allocasuarina* over *Trymalium* and *Styphelia*, in skeletal to shallow soils of red-brown clay-loam on a WNW facing hill slope with abundant coarse fragments of greenstone. Associated grass species included *Austrostipa variabilis*, *Rytidosperma* sp., *Vulpia myuros* f. *megallura* and *Pentameris airoides*.

Conservation status. Listed by Smith and Jones (2018) as Priority One under Conservation Codes for Western Australian Flora under the phrase name *Austrostipa* sp. Mt Holland (W.A. Thompson & J. Allen 948). Only known from a single population of about 50 scattered tussocks. Mining for gold and nickel and further exploration for these and other metals is currently underway in this geological formation. The only known population is not in a protected area. Researchers have been calling for conservation of the distinctive Forresteria Greenstone flora for over 20 years (Thompson & Allen 2013) and this new species of *Austrostipa* adds to the urgency of that case.

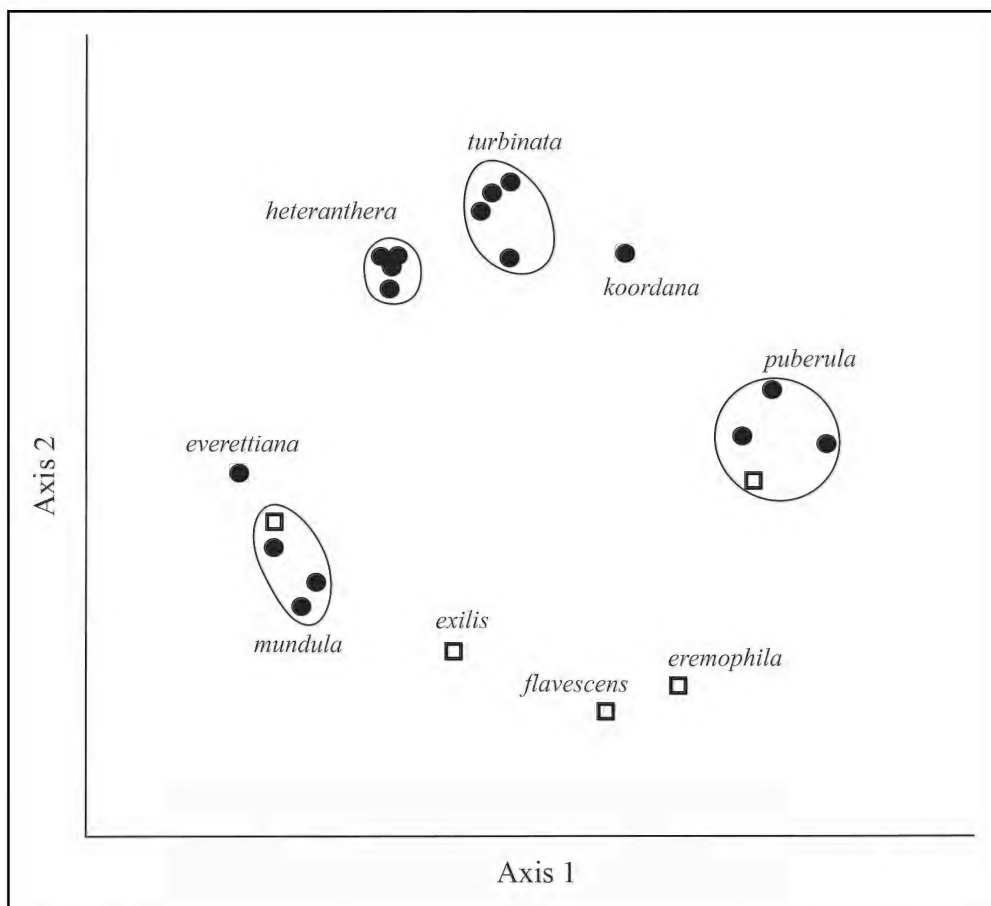


Figure 6. A nonmetric multidimensional scaling (NMDS) plot of new and potentially related previously named taxa in the *Eremophilae* and *Lancea* groups of *Austrostipa* subgenus *Austrostipa*, based on Box-Cox transformed data using the 30 characters listed in Table 1 (axes 1 and 2 of a 2-D plot, stress 0.11). Open squares represent existing taxa (*A. flavescens*, *A. eremophila*, *A. puberula*, *A. mundula* and *A. exilis*, where averaged published character range data were used) and black filled circles represent individual specimen data. Ellipses represent high confidence ($\geq 96\%$) clusters as determined by UPGMA classification using correlation coefficients. Replicate specimens of three new species (*A. turbinata*, *A. heteranthera* and *A. everettiana*) are clearly separated from each other and from all other species included in the analyses. Replicate WA specimens of *A. mundula* clustered with the species description based on specimens from South Australia and Victoria. Replicate specimens of *A. puberula* from WA also clustered with its species description from the literature and were well separated from all others. *A. everettiana* and *A. koordana* are both confirmed as being separate species.

Etymology. Named after Joy Everett, formerly Senior Systematic Botanist at the Royal Botanic Gardens, Sydney, and Scientific Editor of their journal *Telopea*, who with Surrey Jacobs authored or co-authored most of the current primary taxonomic literature on the genus *Austrostipa*.

Affinities. The twice-bent awn column, dark brown mature lemma indumentum with a ‘shaved’ patch on the lemma shoulder and drawn back lemma margins exposing the palea places it in the *Eremophilae* group within subgenus *Austrostipa*. Differences between related taxa in this group are listed in Table 2.

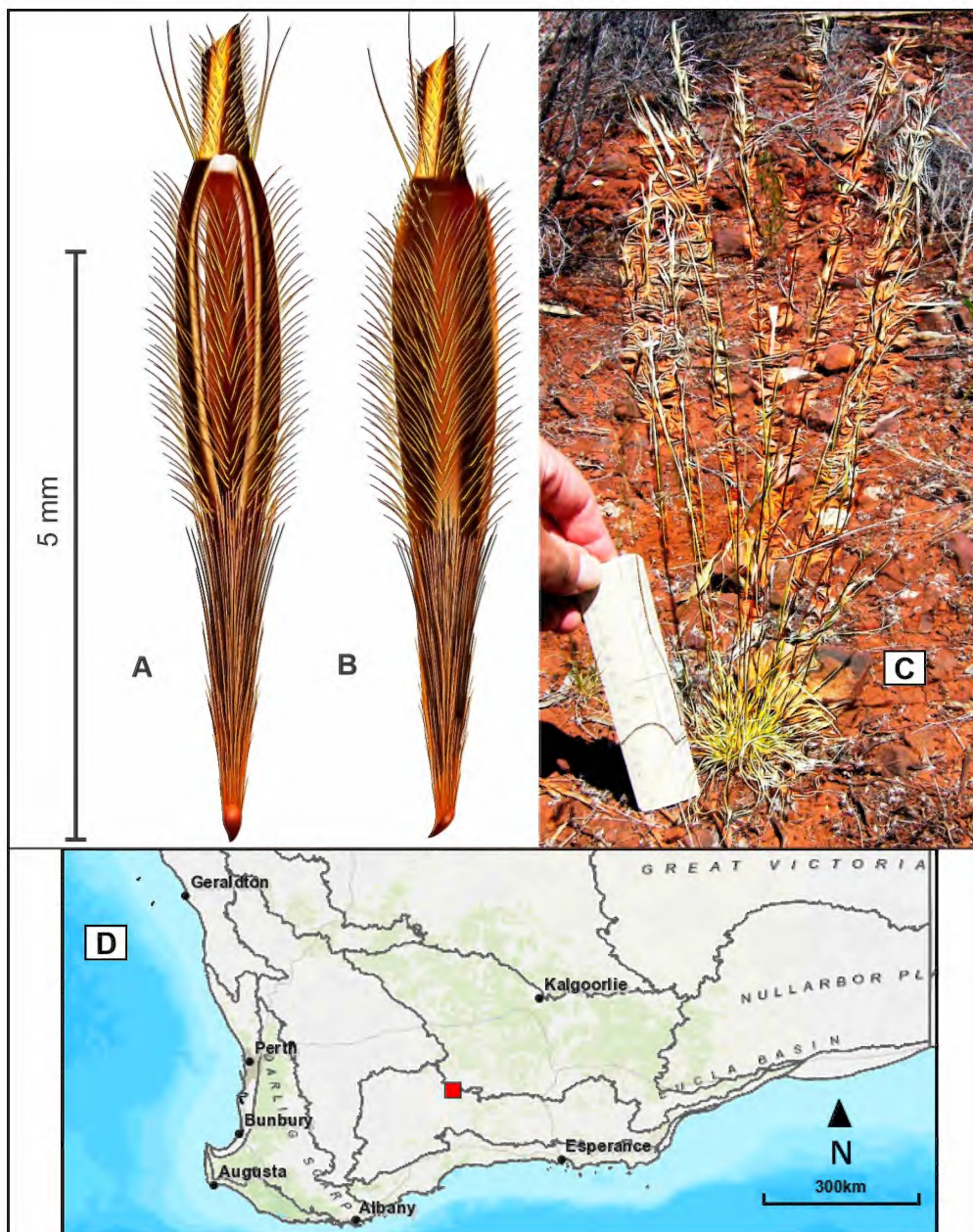


Figure 7. *Austrostipa everettiana*. A – adaxial view of floret showing how the glossy palea margins can be seen through the sparse indumentum; B – lateral view of floret showing the ‘shaved’ patch of short hair on the dorsal lemma shoulder region. C – *in-situ* view of mature tussock, ruler 15 cm long; artificially enhanced for clarity; D – location of the population (■). Vector drawings (A, B) by the author based on A. Dooley AD 428; site photo by Andrew Dooley (C).

2. *Austrostipa koordana* A.R. Williams, *sp. nov.*

Typus: Roadside near Koorda, Western Australia [precise locality withheld for conservation reasons], October 2015, *Anonymous s.n.* (*holo*: PERTH 08730202).

Austrostipa sp. Koorda (Anonymous s.n. PERTH 08730202), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 12 July 2021].

Slender, erect, perennial *tussock grass*, branching extravaginally, *c.* 800 mm tall. *Culms* mostly glabrous, 1–2 mm wide above a densely hairy base (hairs *c.* 1 mm long); nodes 3 or 4, glabrous, enclosed by unusually long and tightly clasping leaf sheaths (200–300 mm long). *Basal leaf* sheaths 3 mm wide, glabrous; upper sheaths glabrous, 3 mm wide. *Ligules* 1.5 mm long, densely pubescent with conspicuous white hairs on margins and abaxially; adaxial surface glabrous. *Auricles* barely present, glabrous. *Leaf blades* 210–280 mm long, rolled, 0.7–1.2 mm wide; abaxial surface glabrous; adaxial surface scabrous. *Panicle* narrow, *c.* 20 mm wide, *c.* 220 mm long, involucre a glabrous ridge; spikelets few and densely clustered at the lower nodes on branches much too short (≤ 15 mm long) to overlap the unusually long internodes (80 mm long). *Spikelets* 12–14 mm long. *Glumes* minutely scabrous, and 3-nerved; lower glume 12–14 mm long, upper glume 11–12 mm long. *Lemmas* 5.8–6.6 mm long, light brown, smoothly rugose, with pale brown hairs, and a ‘shaved’ patch of scabrous hairs on the abaxial shoulder. *Callus* 2–2.6 mm long, sericeous with hairs 0.4–0.5 mm long. *Awn* column pubescent with hairs *c.* 0.4 mm long, twice bent, 7–10 mm to the first bend, and 3–5 mm to the second bend, 0.25–0.3 mm wide at the base; bristle 50–53 mm long, scabrous; total awn length 60–68 mm. *Palea* equal to the lemma. *Lodicules* two; abaxial lodicule spatulate, acute, 0.75 mm long; paleal lodicule 0.75 mm long, linear, obtuse. *Anthers* white (non-pigmented), dwarfed, only one fertile; anterior anther *c.* 1 mm long, fertile; posterior ones 0.4–0.5 mm long, sterile, compressed within cleistogamous lemma. *Caryopsis* 2.7–3 mm long (immature), embryo and hilum not discernible. (Figure 8A–D)

Diagnostic features. The following combination of characters is unique in the *Eremophilae* group in WA: long internodes (80 mm long) in the sparse panicle, with few spikelets clustered at the lower nodes on very short branches; aberrant anther development syndrome; smoothly rugose lemma surface (prominent in the recently dried specimen but much reduced after prolonged drying because the specimen was immature); long (200–300 mm) leaf sheaths that are tightly stem-clasping; and densely pubescent ligules with conspicuous white abaxial hairs.

Phenology. Flowers late spring with fruit maturing in early summer.

Distribution and habitat. Only known from a single roadside collection near Koorda in the Avon Wheatbelt bioregion (Figure 8E).

Conservation status. Listed by Smith and Jones (2018) as Priority One under Conservation Codes for Western Australian Flora under the phrase name *Austrostipa* sp. Koorda (Anonymous s.n. PERTH 08730202).

Etymology. Named after the geographical place name Koorda.

Affinities. Unlike any other members of the *Eremophilae* group (see *Diagnostic features*).

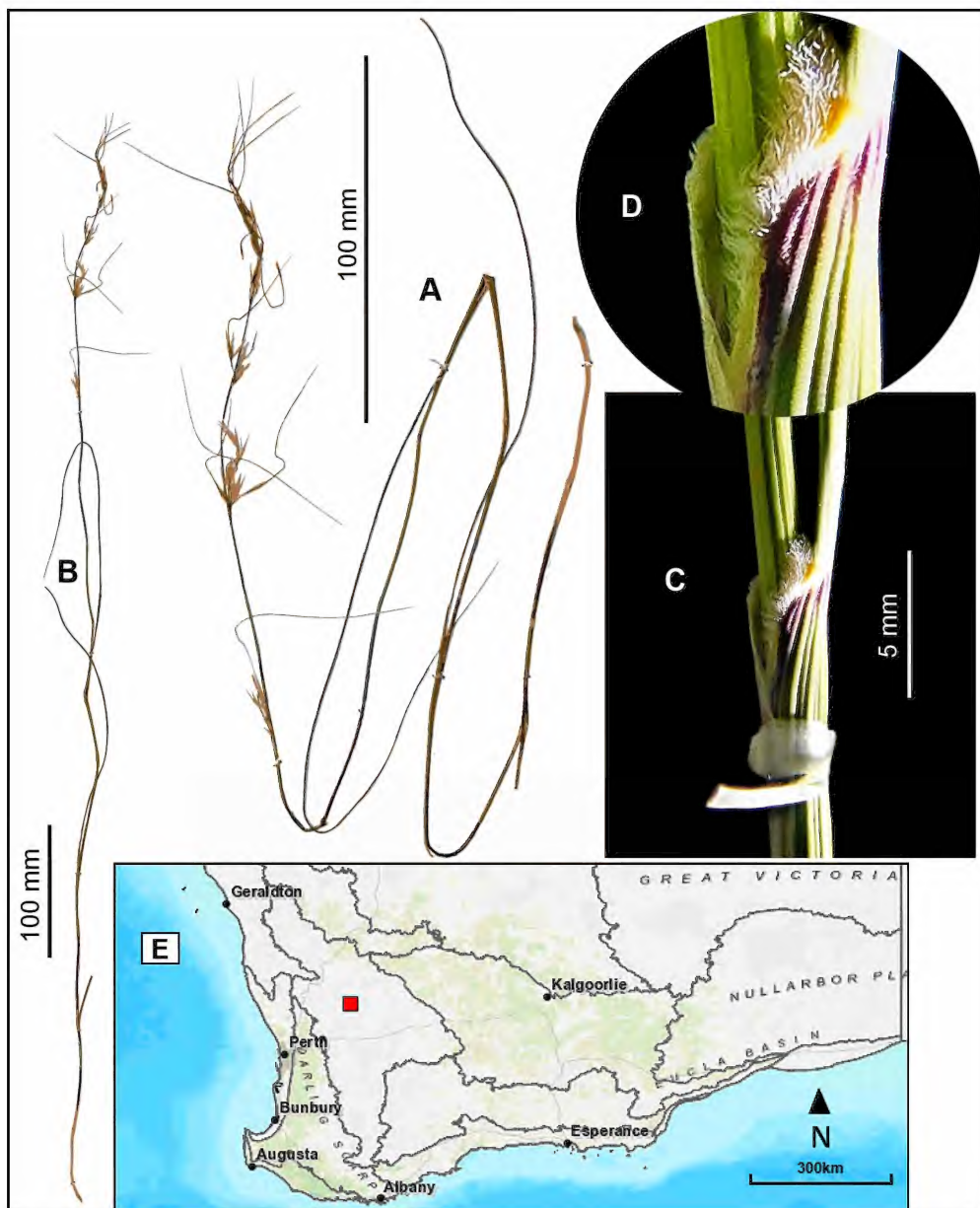


Figure 8. *Austrostipa koordana*. A – single flowering culm from herbarium sheet; B – the same specimen digitally straightened out; C – image of collar region showing conspicuously hairy ligule compared with the glabrous leaf, sheath, and culm, plus the tightly stem-clasping nature of the sheath; D – enlarged view of the collar region; E – location of the population (■). Images by the author from *Anonymous s.n.* PERTH 08730202.

3. *Austrostipa turbinata* A.R. Williams, *sp. nov.*

Typus: Ravensthorpe Range, Western Australia [precise locality withheld for conservation reasons], 6 December 2008, A. Markey & J. Allen 6262A (*holo*: PERTH 08415560; *iso*: CANB).

Austrostipa sp. Carlingup Road (S. Kern & R. Jasper LCH 18459), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 12 July 2021].

Austrostipa aff. *eremophila* in Kern *et al.* (2008).

Perennial *tussock grass*, with densely packed, erect, narrow culms arising from a short rhizome; shoots intra- or extra-vaginal; 250–480 mm tall, without a basal tuft of leaves. *Culms* unbranched, not geniculate; upper culms glabrous or with part indumentum on internodes; nodes 2 or 3, exserted, thickened, sericeous. *Leaf sheaths* tightly enveloping the culm, 0.8–1.3 mm wide at the base of the culm, 0.2–1 mm wide at the upper nodes, glabrous or puberulous and/or with ciliate margins. *Ligules* 0.2–2.5 mm long, blunt; abaxial surface and margin scabrous to pubescent with hairs 0.03–0.2 mm long; adaxial surface glabrous; sheath lobes 0.2–1.2 mm long. *Auricular region* marked at flowering time, with erect hairs 0.1–1.5 mm long. *Leaf blades* green at flowering time, erect at maturity, 40–170 mm long, 0.3–0.6 mm wide, rolled when immature, folded at maturity, sclerophyllous; abaxial surface obscurely ribbed, glabrous and smooth or with short indumentum; adaxial surface strongly ribbed, finely pubescent with hairs 0.03–0.06 mm long. *Panicle* 70–170 mm long, exserted at maturity, contracted, 20–30 mm wide, spikelets sparse, sometimes subtended by a distinct involucre (one odd specimen *c.* 33 mm long); lowest internode 27–58 cm, glabrous or finely scaberulous, the hairs 0.03–0.06 mm long; minimum undivided branch length 1–8 mm, maximum undivided branch length 7–28 mm; branches somewhat flattened with angled edges, 40–80 mm long overall (including glumes); pedicels likewise flattened, 1–7 mm long, scabrous on their angled edges, the hairs 0.1–0.15 mm long. *Spikelets* 12–16 mm long, 6–22 spikelets per node. *Glumes* unequal, acuminate, scabrous on nerves, straw-coloured; lower glume 3-nerved, 10–16 mm long; upper glume 5-nerved, 7–10 mm long. *Floret* turbinate, 5–6.5 mm long, sericeous with golden brown hairs at maturity, 0.7–0.8 mm long, with a ‘shorn’ patch below the lemma where the hairs are *c.* 0.1 mm long. *Lemma* lobes absent or minute; coma 0.8–1.3 mm long. *Callus* 1.5–2 mm long, sericeous with hairs 0.3–1.5 mm long, tip distinctly bent. *Awn* 45–63 mm long, 0.22–0.25 mm wide near the base, twice bent, column 17–24 mm long, 9–13 mm to the first bend, scabrous, with hairs 0.1–0.35 mm long, bristle angular, no broader than column, scabrous with hairs 0.03–0.10 mm long. *Palea* equal to and not completely enclosed by mature lemma, margins glabrous, dorsally pubescent. *Lodicules* 2; 0.6–1.1 mm long, 0.15–0.25 mm wide; obtuse to roundly acute. *Anthers* 3, only one fertile; anterior one fertile, 0.5–1.6 mm long, not penicillate or with one or two penicil hairs; posterior ones sterile, 0.25–0.6 mm long, sometimes with a single penicil hair per locule. *Style* glabrous. *Caryopsis* 2.2–3.6 mm long, *c.* 0.2 mm wide; embryo 0.6–1.0 mm long, hilum 1.7–2.5 mm long. (Figure 9A–C)

Diagnostic features. Lemma hairs dense enough to obscure the lemma margins and palea, dark brown at maturity with an evenly ‘shorn’ patch of short hairs on the shoulder region just below the apex; palea margins not glossy; flowering culms short and narrow, usually ≤ 1 mm wide and ≤ 60 cm tall, erect and densely packed, often indistinguishable from tillers; basal leaf sheaths similar in diameter to tiller and usually ≤ 1 mm wide; mature leaves narrow, indurate, and terete; panicle short and sparse with few spikelets.

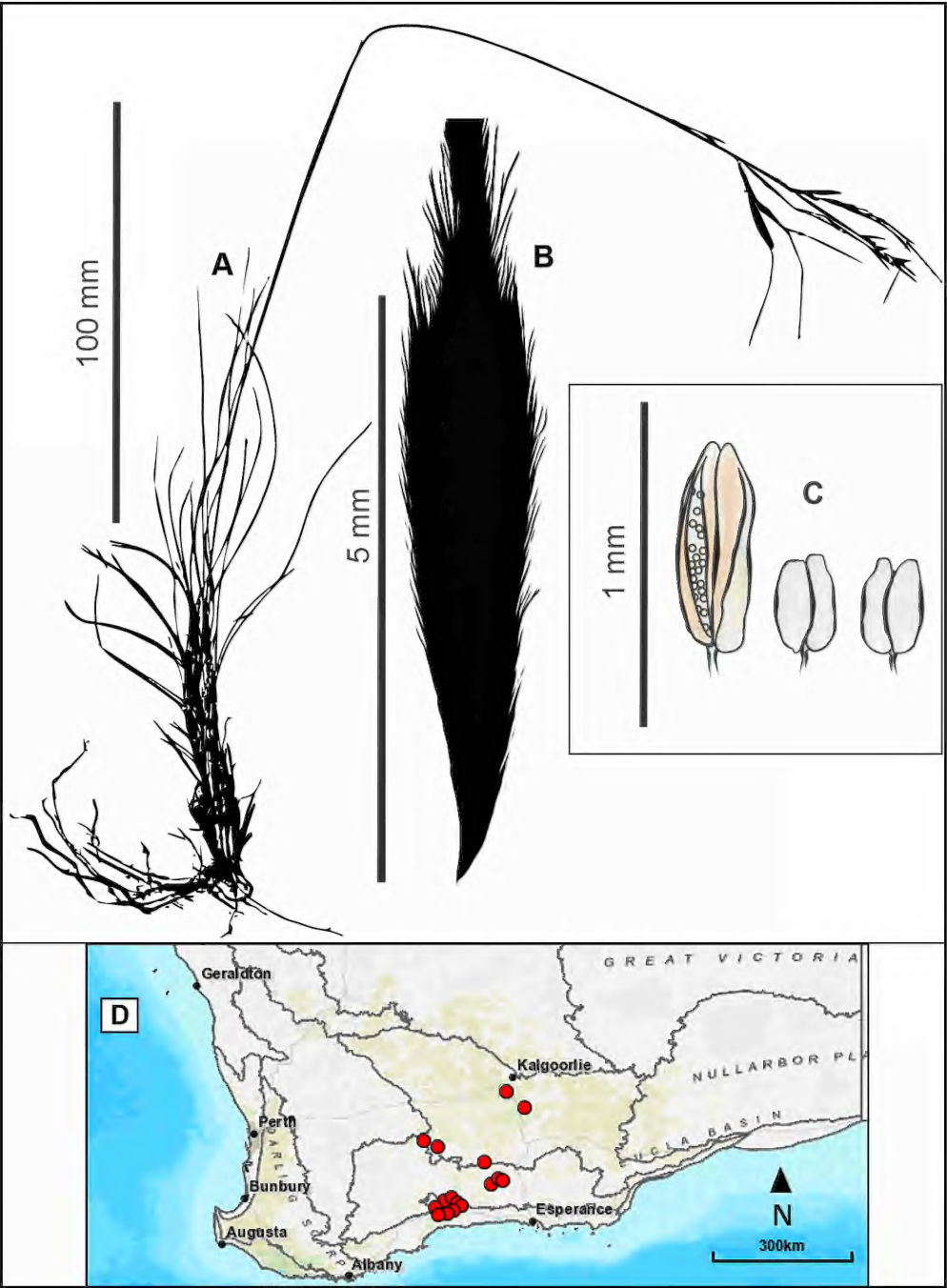


Figure 9. *Austrostipa turbinata*. A – vector outline of the small whole plant with its very small and sparse panicle; B – silhouette image of floret showing the turbinate shape and the short patch of ‘shaved’ hair in the shoulder region; C – vector drawings of rehydrated dwarfed and non-pigmented anthers, only one of which is fertile; D – distribution of *A. turbinata* (●). Illustrations by the author based on *A. Markey & J. Allen* 6268.

Distribution and habitat. Known from the Fitzgerald sub-bioregion of the Esperance Plains bioregion (Figure 9D) in the South-west Botanical Province and from South Australia. Occurs in *Eucalyptus* open forest, woodland and mallee shrubland, on loam or clay soils.

Phenology. Flowers September–October with fruit maturing in November–December.

Etymology. Named for the turbinate shape of the lemma, which is highlighted by the patch of short hairs near the apex and topped with an expanded coma.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 2 Oct. 1983, *M.A. Burgman & S. McNee* 2623 (PERTH); 11 Nov. 2013, *G.F. Craig* 9497–9502 (PERTH); 10 Sep. 2010, *S. Kern* SOK 926 (MEL, PERTH); 5 Oct. 2007, *S. Kern & R. Jasper* LCH 18459 (PERTH); 17 Nov. 2008, *A. Markey & J. Allen* 6267 (PERTH); 6 Dec. 2008, *A. Markey & J. Allen* 6268 (PERTH); 24 Nov. 1997, *W. O'Sullivan* WOS 307 (PERTH); 21 Oct. 2009, *W.A. Thompson & J. Allen* 2219 (PERTH); 1 Apr. 2000, *E. Tink* 475 (PERTH).

Conservation status. To be listed as Priority One under Conservation Codes for Western Australian Flora (Tanya Llorens pers. comm.). Restricted to greenstone ranges. Impaired anther development restricts reproductive success and cleistogamy restricts character variation; together, these factors reduce the prospects of it being found beyond specialized habitats and localised geographical ranges.

Affinities. Similar to *A. puberula* and *A. eremophila* in having a ‘shaved’ patch of short hairs on the lemma shoulder but differs in being smaller in all dimensions than both these species, and in having erect, narrow culms and leaves, tightly clasping leaf sheaths, and the aberrant anther development syndrome. Differs from *A. mundula* in having the aberrant anther development syndrome and a sericeous abaxial ligule surface. Differs from *A. heteranthera* in being cleistogamous, having a turbinate floret with a short patch of ‘shaved’ hairs on the shoulder region, and typically a short indumentum on the foliage.

B. *Lancea* group (previously *Austrostipa* subg. *Lancea* S.W.L.Jacobs & J.Everett)

One new species, *A. heteranthera*, is now included in the *Lancea* group of subg. *Austrostipa*, and two existing species previously known from South Australia, *A. mundula* and *A. echinata*, are now known to occur in very restricted habitats in WA as well. Furthermore, one previously priority listed species, *A. exilis*, has been found to occur commonly throughout the south-west region and has consequently been dropped from the conservation listings.

4. Notes on *Austrostipa exilis* (Vickery) S.W.L.Jacobs & J.Everett

When this study began there were only five collections of *Austrostipa exilis* at PERTH and it had been allocated Priority Two conservation status. There are now 42 collections, distributed throughout the Southwest Province and it has been dropped from the priority list. All but two of these collections have leaves as described by Vickery *et al.* (1986) ‘Leaf blades loosely convolute, flexuose, ... abaxial surface slightly ribbed, scaberulous **and** pubescent **and/or** hirsute [emphases added].’ The two unusual specimens collected in the Ravensthorpe Ranges area (a region well known for unusual specimens in a variety of taxa) had just scabrous leaves without any admixture of longer hairs.

Almost 90% of currently known *A. exilis* collections come from South Australia and most of these have the usual multiple layers of leaf hair types as described above (although Plate 3 in Jessop *et al.*

2006 illustrates three sections of culm, node, leaf sheath and blade, having just hirsute indumentum). However, Vickery *et al.* (1986) noted two odd specimens in SA that had more or less glabrous leaves, but they came from areas of overlap between the distributions of *A. mundula* and *A. exilis*, suggesting possible hybrid status. The reduced leaf indumentum was also common amongst the South Australian loan specimens of *A. exilis* that were sent to us where annotations on these specimens expressed doubt about their identity.

A curious collection of eight plants from the Booylgoo Range in inland WA was initially given the phrase name *Austrostipa* sp. Booylgoo Range (A. Markey & S. Dillon 4581) because in most of its characteristics it matched the falcate species *A. trichophylla*, which was growing nearby in isolated patches at the same survey site, but it had a twice-bent awn, not falcate, which put it out of subg. *Falcatae*. The otherwise closest match was *A. exilis*, but all other WA collections of this taxon at PERTH are located within the Southwest Province, which at its nearest point is at least 400 km from this survey site in the Murchison bioregion. This site is also 580 km inland from the nearest coastline, and where *A. exilis* occurs elsewhere throughout southern Australia (492 records at present) it is nowhere else found more than 260 km inland from the nearest coastline (Australia's Virtual Herbarium map, extracted 17 July 2017, noting that the given scale was incorrect at that time). Interestingly, the leaves on the Booylgoo Range specimens are not flexuose, but erect, and strongly nerved adaxially, which better fits the original description of the species by Vickery (1980). I have concluded for present purposes that this phrase-named taxon should be retained but noting that further study of the *A. exilis* complex across WA and SA is required.

In the above key, white lemma hairs at maturity are said to occur in *A. exilis* as this is the condition in all PERTH specimens. However, Vickery *et al.* (1986) and Everett *et al.* (2009) described the hairs as white or golden and Jessop *et al.* (2006) described them as whitish to golden-brown. Neither these colour variations, nor the 'black lemma' used by Vickery *et al.* (1986) in their key, have been observed in PERTH collections.

5. *Austrostipa heteranthera* A.R.Williams, *sp. nov.*

Typus: Overshot Hill, west of Ravensthorpe Range, Western Australia [precise locality withheld for conservation reasons], 17 November 2008, A. Markey & J. Allen 6260 (*holo*: PERTH 08415552; *iso*: CANB).

Austrostipa sp. Ravensthorpe Range (A. Markey & J. Allen 6261), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 12 July 2021].

Perennial *tussock grass*, with densely packed, erect, narrow culms arising from a short rhizome; shoots intra- or extra-vaginal; 300–700 mm tall, without a basal tuft of leaves. *Culms* unbranched, not geniculate; upper culms glabrous or with part indumentum on internodes; nodes 2, exserted, thickened, sericeous. *Leaf sheaths* tightly enveloping the culm, 0.7–1.3 mm wide at the base of the culm, 0.6–1.2 mm wide at the upper nodes, glabrous or rarely with short indumentum or ciliate. *Ligules* 0.3–0.8 mm, blunt; abaxial surface and margin sericeous; adaxial surface glabrous; sheath lobes 0–1.2 mm long. *Auricular region* marked, with erect hairs 0.1–1.2 mm long. *Leaf blades* green at flowering time, erect, 35–150 mm long, 0.3–0.7 mm wide, rolled or involute; abaxial surface not ribbed, glabrous and smooth, rarely scabrous or pubescent; adaxial surface strongly ribbed, pubescent with an even covering of erect hairs 0.03–0.06 mm long. *Panicle* 60–210 mm long, exserted, contracted, 20–30 mm wide, spikelets sparse, not subtended by a marked involucre; lowest panicle internode 27–50 mm long, finely scaberulous, the hairs 0.01–0.03 mm long; minimum undivided branch length 1–7 mm,

maximum undivided branch length 6–17 mm; branches with acutely angled edges, 25–55 mm long overall including glumes; pedicels likewise angular, 2–12 mm long, scabrous on their edges, the hairs 0.05–0.2 mm long. *Spikelets* 4–12 per panicle node, 10–16 mm long. *Glumes* unequal, acuminate, scabrous on nerves, straw-coloured; lower glume 3-nerved, 10–16 mm long; upper glume 5-nerved, 6.5–10 mm long. *Floret* fusiform, 4.5–6.5 mm long, sericeous with an even covering of yellowish-brown hairs at maturity, 0.5–1.2 mm long, indumentum sometimes sparse near the apex with scabrous trichomes c. 0.03 mm long. *Lemma* lobes absent or minute; coma 0.8–1.3 mm long. *Callus* 1.5–2 mm long, sericeous with hairs 0.5–0.6 mm long, tip weakly bent. *Awn* 40–60 mm long, 0.22–0.3 mm wide near the base, twice bent, column 17–24 mm long, 8–13 mm to the first bend, scabrous, with hairs 0.05–0.3(–0.6) mm long, bristle straight, angular in cross section, no broader than the column, scabrous with hairs 0.07–0.15 mm long. *Palea* equal to and not enclosed by the mature lemma, margins glabrous, pubescent along and between dorsal nerves. *Lodicules* not found. *Anthers* 3, only one fertile; anterior one fertile, 0.75–1.1 mm long, not usually penicillate; posterior ones 0.3–0.7 mm long, usually having a single penicil hair per locule. *Style* glabrous. *Caryopsis* 2.7–4 mm long, c. 0.2 mm wide; embryo 0.7–1.1 mm long; hilum 1.8–2.5 mm long. (Figure 10A–C)

Diagnostic features. Flowering culms short and narrow, usually ≤ 1 mm wide and ≤ 600 mm tall, almost indistinguishable from innovations, erect and densely packed; basal leaf sheaths similar in diameter to tiller basal sheaths and usually ≤ 1 mm wide; mature leaves narrow, indurate and terete; leaf sheaths and blades glabrous or pubescent (hairs $\ll 0.5$ mm); lemma with brown hairs at maturity; anthers translucent white when re-hydrated, of different sizes, one fertile and 0.8–1.1 mm long, the other two sterile and 0.4–0.6 mm long.

Distribution and habitat. Occurs mainly in the Fitzgerald sub-bioregion of the Esperance Plains bioregion (Figure 10D). Forest, woodland, mallee shrubland and low heath. In loamy soils over ironstone or granite.

Phenology. Flowers October–November with fruit maturing in November–December.

Etymology. Named for the unusually dwarfed and unpigmented anthers of different lengths, only one of which is fertile, while the other two remain very short and sterile, i.e., they are staminodes (grasses generally have three long anthers of equal length).

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 26 Sep. 1984, *M.A. Burgman* 3648 (PERTH); 11 Nov. 2013, *G.F. Craig* 9492–9496 (PERTH); 1 Nov. 2008, *A. Markey & J. Allen* 6261 (PERTH); 6 Dec. 2008, *A. Markey & J. Allen* 6262 (PERTH); 6 Dec. 2008, *A. Markey & J. Allen* 6263 (PERTH); 5 Dec. 2008, *A. Markey & J. Allen* 6264 (PERTH); 22 Nov. 2008, *A. Markey & J. Allen* 6265 (PERTH); 19 Nov. 2008, *A. Markey & J. Allen* 6266 (PERTH); 11 Dec. 2008, *A. Markey & J. Allen* 6272 (PERTH); 1 Nov. 2009, *W.A. Thompson & J. Allen* 2220 (PERTH); 22 Oct. 2009, *W.A. Thompson & J. Allen* 2221 (PERTH); 27 Oct. 2009, *W.A. Thompson & J. Allen* 2222 (MEL, PERTH); 27 Oct. 2009, *W.A. Thompson & J. Allen* 2223 (PERTH); 21 Oct. 2009, *W.A. Thompson & J. Allen* 2224 (PERTH).

Conservation status. Recently downgraded to Priority Two (Western Australian Herbarium 1998–) under Conservation codes for Western Australian Flora, under the phrase name *Austrostipa* sp. Ravensthorpe Range (*A. Markey & J. Allen* 6261). Restricted to Ravensthorpe Ranges. The reduction to a single functional anther in this taxon is likely to restrict reproductive success and this may limit it to specialized habitats and localised geographical ranges.

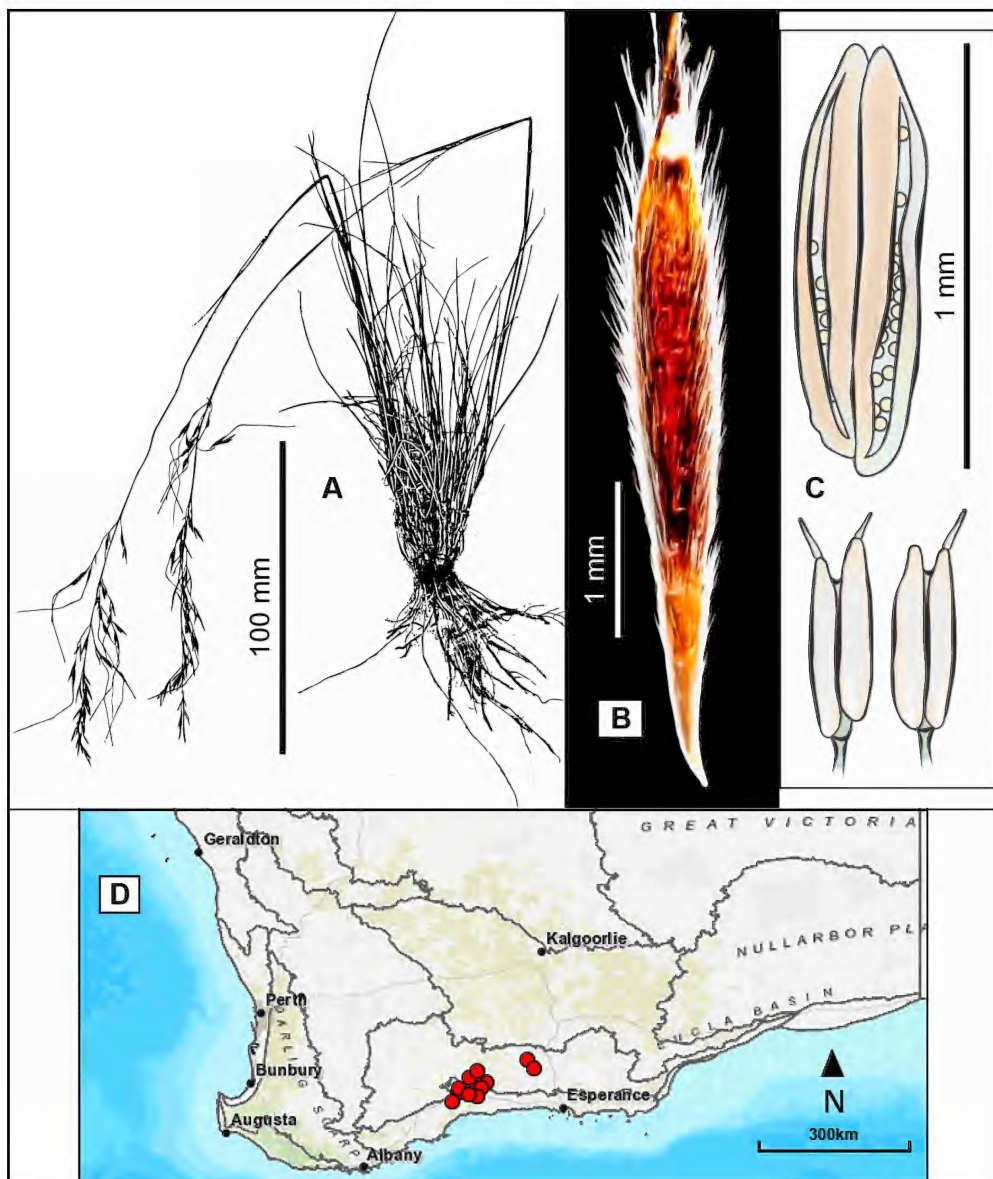


Figure 10. *Austrostipa heteranthera*. A – vector outline of mature whole plant; B – backlit image of a mature floret showing hair distribution in the shoulder region; C – vector drawings of rehydrated stamens, the anterior one (top) is fertile and the posterior two (below) are penicillate and sterile; D – distribution of *A. heteranthera* (●). Illustrations by the author based on A. Markey & J. Allen 6267.

Affinities. Differs from *A. mundula* and very small specimens of *A. flavescens* in its habit (erect, densely packed culms, sheaths, and leaves) and in having the aberrant anther development syndrome. Similar to *A. turbinata* in most characteristics but differs in having a fusiform lemma with an even covering of hairs (no 'shaved patch' as shoulder ornament), being chasmogamous rather than cleistogamous, and with glabrous leaves; it grows together with this species at Ravensthorpe Range survey site R216.

6. Notes on *Austrostipa mundula* (J.M.Black) S.W.L.Jacobs & J.Everett

The distribution of *A. mundula* is shown in Figure 11, with the previously known populations in South Australia and Victoria separately coloured (red) from the newly identified Western Australian collections (black). The species occurs in WA only in small isolated coastal populations from east of Esperance around to north of Perth. The four populations sampled in the Perth area (in 1902, 1960, 1963, and 1967) may correlate with the intensity of collection effort in that area so more collecting at other coastal locations may locate further populations. Two of the Perth populations are now extinct through urban development. The surviving population in the south is in a tiny reserve surrounded by industrial development, and the population in the north is in the urban growth region of Yanchep.

Only two characters were found to differ between the WA collections and the published description of *A. mundula*: WA collections had penicillate anthers, and hairs on the abaxial surface of the ligule. Examination of the type specimens of *A. mundula* revealed that there were some sparse hairs (sometimes only lower down) on the backs of the ligules, so that character can be eliminated from the published differences. The penicil difference, however, was confirmed to be real.

The WA collections of *A. mundula* have only one, or rarely two, fragile penicil hairs on each anther locule, while other existing members of the *Lancea* group are fully penicillate with several hairs per locule. The new species *A. heteranthera* and *A. turbinata* sometimes have a single penicil hair per locule and sometimes only on the staminodes. Does this single character justify subspecies status for the WA collections? I have chosen not to recognize subspecies status on this single character because the penicil hairs on WA *A. mundula* (and in *A. heteranthera* and *A. turbinata*) are mostly singular and unusually fragile and can be dislodged during dissection and sample preparation whereas other *Austrostipa* species usually have several penicil hairs that are quite robustly attached.

It is possible that in earlier (perhaps wetter) times, *A. mundula* may have extended right across southern WA, but then retreated during a subsequent drying phase to its currently isolated coastal positions. This scenario would be consistent with the phylogeographic review of Byrne (2008), who found widespread patterns of geographically isolated populations in many different biota of southern Australia, resulting from oscillating periods of expansion from, and contraction to, major refugia during Pleistocene climatic changes. Further studies that include molecular data could perhaps clarify the situation.

Loan specimens of *A. mundula* from South Australia (AD) included two leaf types (one form is uniformly curved in a single stiffened arc from the base, the other is straight and stiffly erect), but the type specimens are both of the former type with uniformly curved leaves in a single stiffened arc. Collections from WA likewise include specimens with either one or other of these leaf types. This difference should be taken into account in any further taxonomic work on this species.

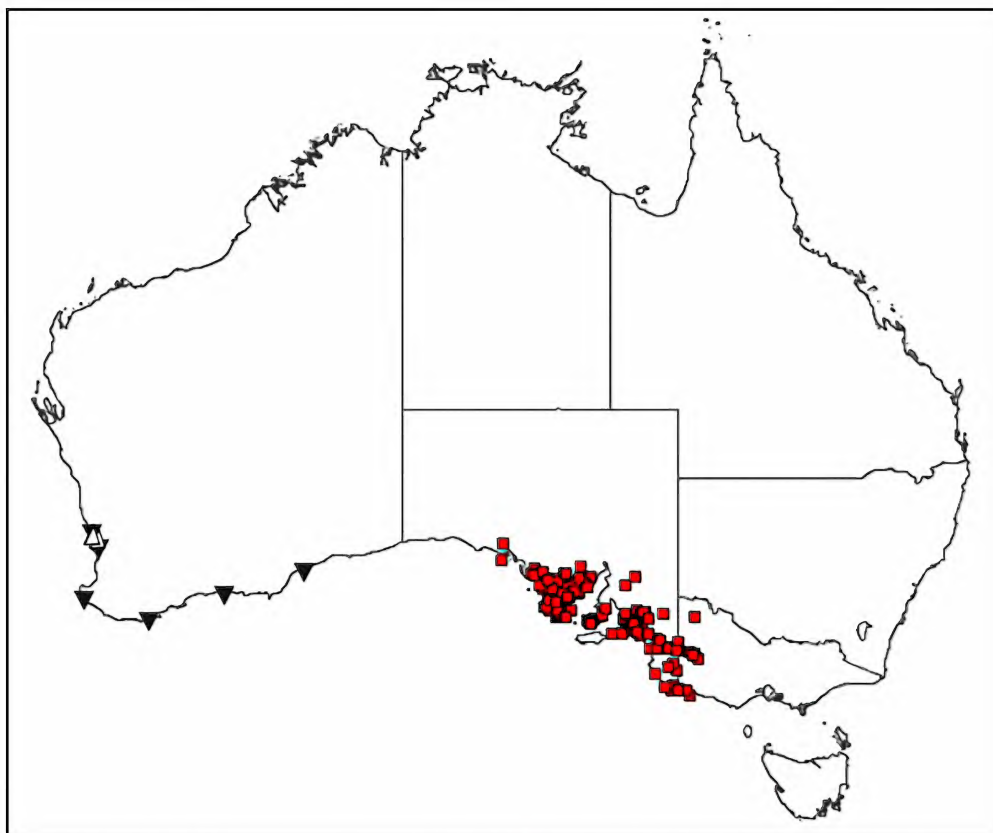


Figure 11. Distribution of *Austrostipa mundula* prior to this study (■) in southern South Australia and western Victoria, specimen data reproduced with permission from *Australasian Virtual Herbarium* (AVH 2012). Distribution of newly identified populations in Western Australia (▼) and earlier known populations now extinct (Δ).

C. *Lanterna* group (previously *Austrostipa* subg. *Lanterna* S.W.L.Jacobs & J.Everett)

Austrostipa subg. *Lanterna* was differentiated from its near relatives (which have twice-bent awns and dark brown lemmas and lemma hairs) in the *Flora of Australia* (Everett *et al.* 2009) as follows: ‘Lemma glabrous or almost so, with surface smooth and shining.’ The alternative couplet describes the surface of any glabrous portion of the lemma as being ‘rough (tuberculate or ‘crystalline’ with individual small bumps or ridges of translucent silica)’. The leaf sheath margins, auricles, and ligules in subg. *Lanterna*, now included within subg. *Austrostipa*, also bear highly distinctive very long and crinkly-woolly hairs, while species in other groups have shorter and usually straight hairs in these locations. From my observations, the species in the *Lanterna* group also appear to be exclusively cleistogamous, with dwarfed and non-pigmented anthers. This small group, according to Everett *et al.* 2009, consisted of just three species that occur in arid and semi-arid southern inland regions from eastern Western Australia to western Victoria and New South Wales.

Within this group *A. lanata* (Vickery, S.W.L.Jacobs & J.Everett) S.W.L.Jacobs & J.Everett is distinguishable because of its entirely glabrous lemma with its margins not concealing the entirely glabrous palea. The other two species, *A. vickeryana* (J.Everett & S.W.L.Jacobs) S.W.L.Jacobs &

J. Everett and *A. nullanulla* (J. Everett & S.W.L. Jacobs) S.W.L. Jacobs & J. Everett, were described as having a lemma with a sparse indumentum (rarely glabrous) which completely encloses the palea. The type specimens for each of these latter two species are clearly distinguishable from one another but only a few specimens of each species were available to the original authors, Everett and Jacobs (1983). As more specimens have accumulated since that time the differences noted in the protologues have begun to blur and overlap, suggesting that a new study was required, so a comprehensive survey was carried out across all available specimens (from PERTH, AD, MEL, and NSW) including type specimens.

Vickery *et al.* (1986) stated in the description of *A. vickeryana* that it ‘differs from *A. nullanulla* in having coarser, usually folded leaves (rolled in *A. nullanulla*), a less open inflorescence and longer lemma and awn.’ In their key, they chose lower glume length and awn length as the clearly distinguishing characters, and in a multiple-entry key the lemma length ranges were given as 6–7 and 5–6 mm respectively. I found no discernible differences in the leaf blades between these two species. Freitag (1985), in describing the large collection of Asian *Stipa* specimens available to him, distinguished two kinds of leaf blades — thin (in more moist environments) and thick (in drier environments). Under water stress both kinds of leaf blade typically roll or fold inwards (to become involute or conduplicate) and they reduce water loss by depositing extra sclerenchyma under the outer (abaxial) surface layer. This is not sufficient in thin blades to obscure their ribbed appearance on the outer (abaxial) surface, but in thick blades the extra sclerenchyma does obscure the ribs (vascular bundles) so that the abaxial surface becomes smooth and the rolled or folded blade becomes almost circular in cross section. Freitag (1985) described this latter condition as xeromorphic, however it had been described earlier by Hughes (1921) and termed sclerophyllous in Australian *Stipa*, so I retained that terminology here. Neither Vickery *et al.* (1986) nor Everett *et al.* (2009) recognized this leaf condition, even though both species typically occur in saline arid or semi-arid (i.e., xeric) habitats. All mature leaves on specimens that I examined were characteristically sclerophyllous, but younger leaves were more varied in appearance.

The inflorescences in both species were all contracted in mature plants, especially after floret disarticulation, but they were larger in larger plants, and broader when they were fully laden with fresh young florets, which is also when the panicle branches were most pliable and there was a larger mass for gravity to pull the branches downward and thus also outwards. I saw no evidence of pulvini in branch axils that might also have contributed to this effect. Leaf and panicle data were not included in the keys provided in Vickery *et al.* (1986) and Everett *et al.* (2009), suggesting that these authors did not consider their noted characters to be consistently reliable. Gonzalez *et al.* (2012) and Freitag (1985) studied character reliability in *Stipa s. str.* and they found that floral characters proved consistently more reliable than vegetative characters, so I focussed on the following floral characters that were listed as reliably diagnostic in the published keys: lower glume length, awn length, awn column length, column length to the first bend, column length from the first to second bend, bristle length, and lemma length.

Sixty-two fertile specimens were examined, of which 12 were identified as *A. vickeryana* and 50 as *A. nullanulla*. An UPGMA classification of specimens using Euclidean distance produced a group of 28 that included the two *A. vickeryana* type specimens, and a group of 34 specimens that included the two *A. nullanulla* type specimens. Several ordination methods all produced a continuum of variation with no discernible disjunctions between these two groups of specimens, as illustrated in Figure 12, and discriminant analysis likewise did not extract two significantly different groups. The two groups appear to simply distinguish specimens with smaller floral parts (*A. nullanulla*) from those with larger floral parts (*A. vickeryana*) as illustrated in Figure 12. Jessop *et al.* (2006) noted the same result of their studies, saying ‘The differences between [the two species] are entirely in measurements, such as glumes, lemma and awn lengths. A specimen from near Tallaringa Well (NW) is intermediate between

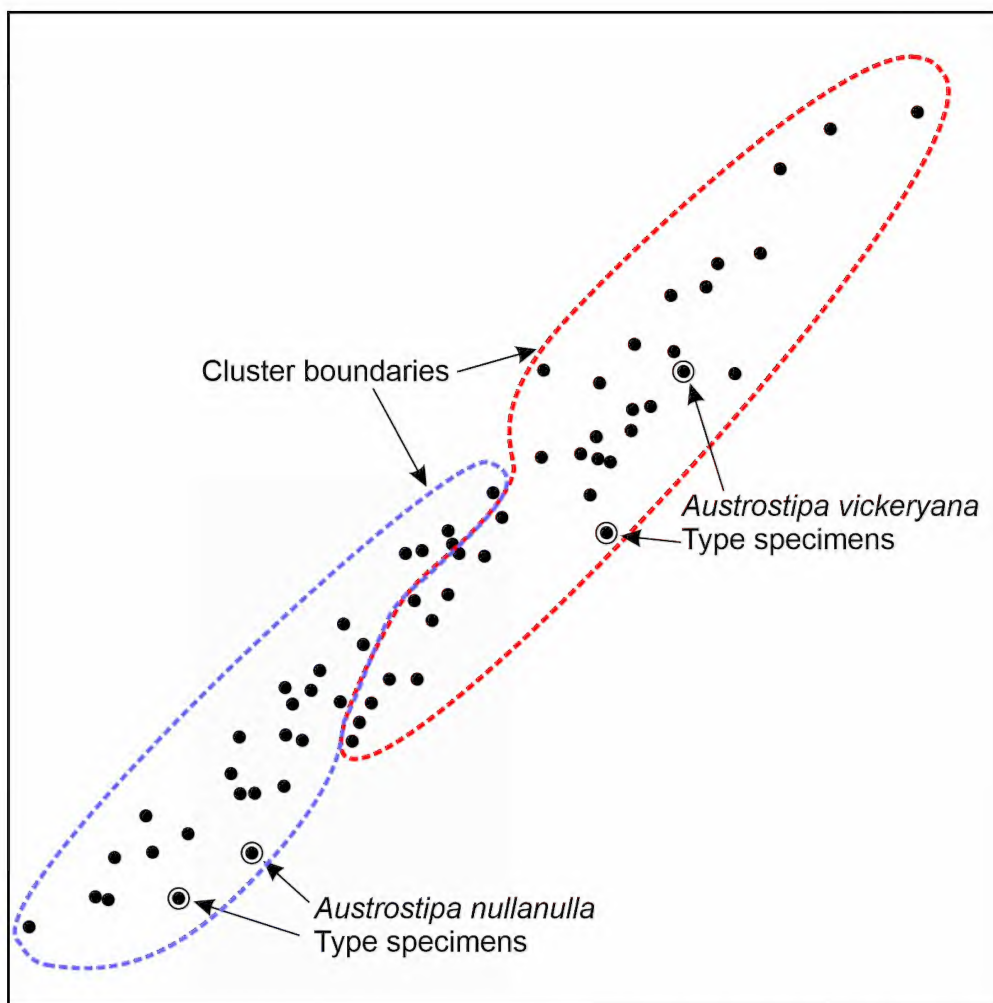


Figure 12. Overlapping character states in *Austrostipa vickeryana* and *A. nullanulla*. Non-metric multidimensional scaling plot of 62 specimens based on 7 floral characters, rotated 45° to reflect generally increasing floral character sizes from left to right (98% of the variance is represented in the long axis, with 1% in the narrow axis). Type specimens of *Austrostipa vickeryana* and *A. nullanulla* are circled and labelled. The dashed lines enclose the two groups identified in a UPGMA classification of Box-Cox normalized data. The type specimens were clearly distinct from one another originally, but if they had really represented two separate species then a disjunction should occur within the larger sample of specimens. There is no such disjunction, but rather a large overlapping region between the two groups, so the two names simply represent a trend from specimens with generally smaller floral parts on the left (*A. nullanulla*) to those with generally larger floral parts on the right (*A. vickeryana*) within a single-species complex.

these two species and cannot be identified.’ Accordingly, I have reduced *A. nullanulla* to become a synonym of *A. vickeryana*.

Molecular analyses by Jacobs *et al.* (2007) on the systematics of the tribe *Stipeae* included both *A. nullanulla* and *A. vickeryana*. They found that *A. nullanulla* separated at a terminal branch of the cladogram from *A. blackii* (these two species are strikingly different morphologically) and these two then joined *A. vickeryana* at the next branch point. Similar terminal triplet patterns were found in triplicate within-species specimens of *A. elegantissima*, *A. ramosissima*, and *A. scabra*, which

suggests that *A. nullanulla* and *A. vickeryana* differ only at a within-species level (the suggested connection between *A. nullanulla* and *A. blackii* is morphologically quite spurious). Furthermore, the same terminal triplet pattern also occurred on a nearby branch that joined *Achnatherum pinetorum*, *Austrostipa mollis* and *Nasella argentinensis*, indicating that the data were not providing any useful phylogenetic information at the species level at all. This study was based on nuclear ribosomal ITS sequences and a review by Alvarez and Wendel (2003) listed so many problems using ribosomal ITS sequences they concluded, ‘we recommend that ITS no longer be routinely utilized for phylogenetic analyses.’ It therefore seems premature to place any species-level taxonomic weight on this particular result in Jacobs *et al.* (2007).

Key to the species in *Lanterna* group

1. Lower glume 15–26 mm long; ligules 0.4–1.5 mm long; lemma and palea usually entirely glabrous, palea fully or at least clearly exposed at maturity **A. lanata**
- 1: Lower glume 9–18 mm long; at least some ligules >> 2 mm long; lemma and palea sparsely hairy (rarely both glabrous), palea fully and firmly enclosed by lemma throughout development..... **A. vickeryana**

7. *Austrostipa lanata* (Vickery, S.W.L.Jacobs & J.Everett) J.Everett & S.W.L.Jacobs, *Telopea* 6: 586 (1996). *Stipa lanata* Vickery, S.W.L.Jacobs & J.Everett, *Telopea* 3: 68 (1986). *Type*: north of Mundrabilla Homestead, Western Australia [precise locality withheld for conservation reasons], 31 July 1974, A.A. Mitchell 2 (*holo*: PERTH 00985961!).

Perennial *tussock grass*, 300–450 mm tall. *Culms* 1–2 mm wide near the base, terete, ribbed, glabrous to pubescent, especially below the nodes; nodes 1 or 2, glabrous to puberulous, exerted only in older, geniculate culms. *Leaf sheaths* broad, the upper sheaths inflated, innovations held tightly into bundles; ribs of lowermost sheaths long-woolly to hirsute, pubescent between the ribs, to glabrous with age on uppermost sheaths; outer margin glabrous to long-woolly ciliate, especially just below the ligule; inner margin glabrous. *Ligules* 0.4–1.5 mm long, truncate, densely ciliate. *Auricular region* with conspicuous long woolly hairs. *Leaf blades* expanded to loosely rolled, 100–200 mm long, 1.5–4 mm wide, abaxial surface unribbed to strongly ribbed, glabrous above to antrorsely hirsute on lower leaves; adaxial surface strongly ribbed, pubescent, the hairs short, more or less antrorse. *Panicle* 10–15 cm long, contracted, generally few-flowered, the base enclosed by the sheath except when mature; axis terete, pubescent, ribbed; branches terete, 10–40 mm long, hirsute to pubescent; pedicels angular, 4–15 mm long, hirsute to pubescent. *Spikelets* 15–26 mm long, slightly gaping at maturity after floret disarticulation. *Glumes* unequal, smooth, firm and often purple-coloured at the base, hyaline at the acuminate tips; lower glume 15–26 mm long, 3-nerved in lower part; upper glume 14–19 mm long, 5-nerved in lower part. *Floret* turbinate, 6–8 mm long, with a neck. *Lemma* deep brown at maturity, smooth, shiny, entirely glabrous (1 specimen had some hairs) except for a minutely scaberulous dorsal patch of antrorse hairs on the neck; lemma margins smoothly drawn back to expose the entirely glabrous palea (1 specimen had some hairs); coma present but sparse, in two tufts, 1–1.5 mm long. *Callus* prominent 3–4 mm long, straight, the hairs white or coppery to dark rusty brown at maturity. *Awn* 50–80 mm long, 0.4–0.5 mm wide near the base, twice bent; column 20–30 mm long, 8–15 mm to the first bend, densely pubescent, hairs 0.1–0.3 mm long; bristle antrorsely scabrous. *Palea* subequal to the lemma, obtuse, ciliate at the tip but otherwise glabrous and shiny. *Lodicules* 2–3; abaxial lodicules membranous, c. 1 mm long, oblong; paleal lodicule absent or acute, 0.5–0.8 mm long. *Anthers* unpigmented, dwarf, 0.3–0.4 mm long. *Style* glabrous. *Caryopsis* 4 mm long; embryo c. 30% the length, hilum c. 85% the length. (Figure 13D–G)

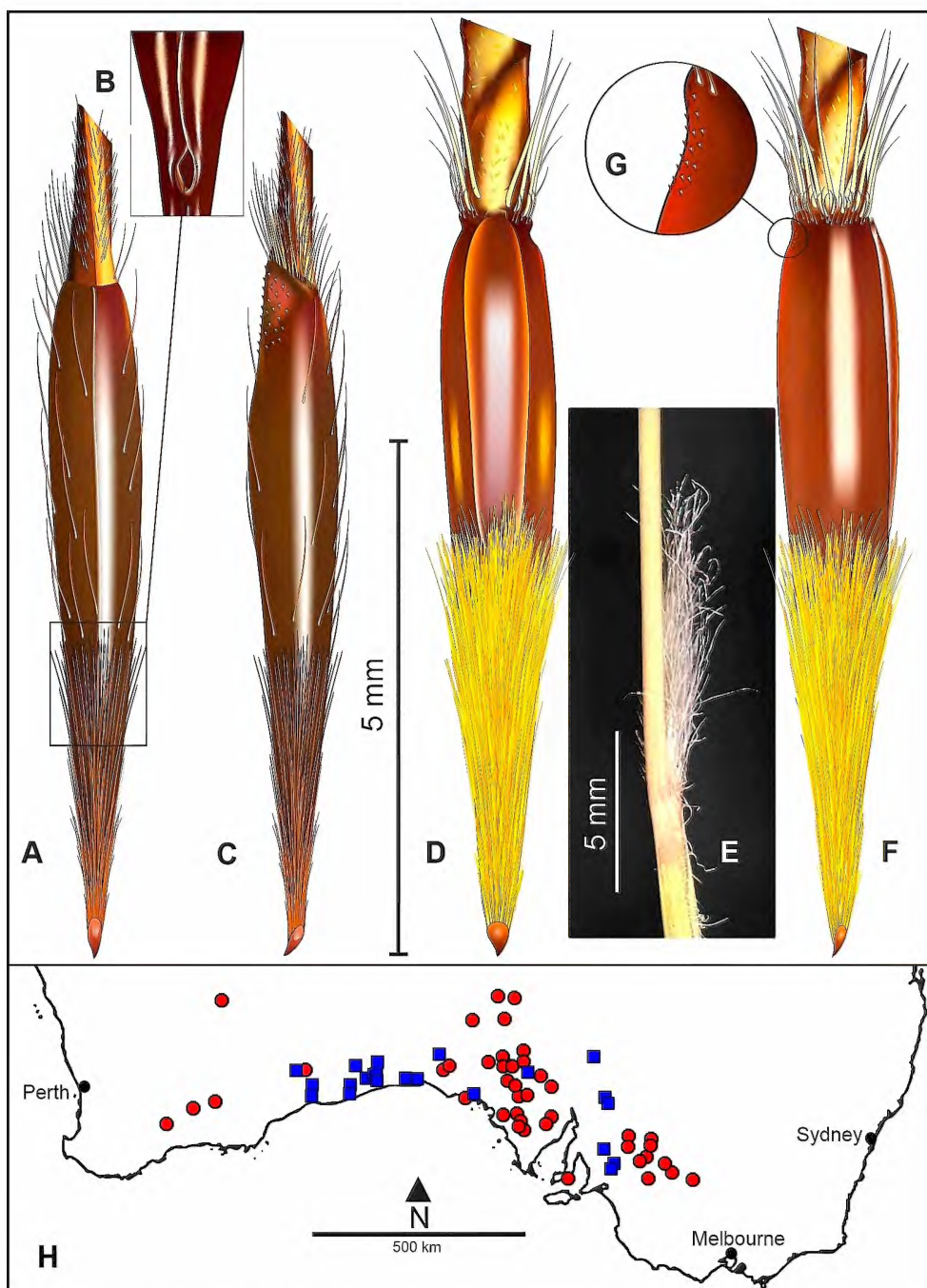


Figure 13. *Lanterna* group of *Austrostipa* subgenus *Austrostipa*. A–C *A. vickeryana*; A – floret, adaxial view, lemma margins overlapping; B – magnified lemma base with hairs removed, lemma margins diverge initially but then fold back and overlap; C – floret, lateral view; D–G *A. lanata*; D – floret, adaxial view; E – leaf sheath/blade collar region showing very long hairs on the ligule; F – floret lateral view; G – enlarged view of the scabrid neck region; H – distribution of *A. lanata* (■) and *A. vickeryana* (●), data from Australia's Virtual Herbarium (AVH 2016). Illustrations by the author based on *W. O'Sullivan* WOS303 (A–C); *A.A. Mitchell* 2 (D, F); and *F.M. Hilton* 234 (E).

Diagnostic features. Differs from *A. vickeryana* in the lemma and palea being entirely glabrous, the lemma margins being drawn back to expose the palea throughout development, and ligules 0.5–1.5 mm long. Distinguished from other species with twice-bent awns and dark brown lemmas and lemma hairs by the smooth and shiny lemma and palea surfaces and the leaf sheath margins, auricles and ligules bearing very long and crinkly-woolly hairs.

Specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 22 June 1966, *D.W. Goodall* 2705 (PERTH); 30 Aug. 1930, *E.R.L. Johnson* 68 (PERTH); Aug. 1930, *M.B. Johnston s.n.* (PERTH); 6 Dec. 1993, *J. Landsberg & J.M. Stol* 86 (PERTH); 7 Dec 1993, *J. Landsberg & J.M. Stol* 88 (PERTH). SOUTH AUSTRALIA: Nov. 2005, *Anon. s.n.* (AD); 5 Oct. 1966, *A.C. Beauglehole* 20041 (AD, NSW); 27 Nov. 1980, *J. Everett* 160 & *S.W.L. Jacobs* (NSW); 28 Nov. 1980, *J. Everett* 165 & *S. Jacobs* (NSW); 16 Oct. 1952, *F.M. Hilton* 234 (AD); 10 Oct. 1986, *G.J. Keighery & J.J. Alford* 875 (NSW); 19 Oct. 1997, *D.E. Murfet* 2977 (AD).

Phenology. Flowers June to December, fruits mature late-spring to early summer.

Distribution and habitat. Inland south-eastern Western Australia in the Coolgardie, Mallee, Murchison and Nullarbor bioregions, to western and central South Australia (Figure 13H), on shallow calcareous soils.

Conservation status. Recently listed as Priority Three (Western Australian Herbarium 1998–) under Conservation Codes for Western Australian Flora. While it is rarely collected *A. lanata* occurs across a wide geographic range in Australia.

Etymology. From Latin meaning ‘woolly’, regarding the sheath orifice indumentum.

Affinities. Considered by the original authors to be most similar to *A. eremophila* (of the *Eremophilae*), but later separated into the *Lanterna* group by Jacobs and Everett (1996).

8. *Austrostipa vickeryana* (J.Everett & S.W.L.Jacobs) S.W.L.Jacobs & J.Everett, *Telopea* 6: 589 (1996); *Stipa vickeryana* J.Everett & S.W.L.Jacobs, *Telopea* 2: 397 (1983). *Type:* Ifould Lake, Nullarbor Plain, South Australia, 2 October 1975, *R.J. Chinnock* 2729 (*holo:* AD 97546275!; *iso:* NSW 300383!).

Austrostipa nullanulla (J.Everett & S.W.L.Jacobs) S.W.L.Jacobs & J.Everett, *Telopea* 6: 587 (1996); *Stipa nullanulla* J.Everett & S.W.L.Jacobs, *Telopea* 2: 397 (1983). *Type:* ‘Nulla Nulla’ 2 km south of gate at northern end of Bluff Paddock. 25 November 1980, *J. Everett* 133 & *S.W.L. Jacobs* (*holo:* NSW 300364!; *iso:* AD 98414080!).

Annual or perennial *tussock grass*, 400–450 mm tall. *Culms* (1.5–)2–2.5 mm wide near the base, terete to flattened (slightly), mostly glabrous but may be pubescent below the nodes; culm basal region glabrous; nodes 1 or 2, glabrous, rarely exserted. *Leaf sheaths* loose, glabrous, scabrous, or pubescent on the lowermost sheath bases or between the nerves, margins with long woolly cilia. *Ligules* membranous, lacinate, 1–8(–13) mm long, margin densely ciliate with long woolly hairs to 9 mm on tips and back, especially on those of the lower sheaths. *Auricular region* with conspicuous hairs. *Leaf blades* rolled or folded at maturity, 10–30 cm long, 1–4 mm wide; abaxial surface unribbed, glabrous or very sparsely scaberulous; adaxial surface strongly ribbed, pubescent, the hairs short, margins scabrous. *Panicle* 9–20 cm long, exserted or included (the base enclosed by the sheath), slightly spreading when loaded with florets, narrow after they have fallen; branches 4–60 cm long, scaberulous, scabrous or shortly

pubescent; pedicels similar, 3–15 cm long. *Spikelets* 9–18 mm long, slightly gaping (at maturity) or widely gaping (after floret disarticulation). *Glumes* unequal, finely acuminate, scaberulous (on the nerves) or glabrous (between the nerves) or pubescent (minutely, especially at the tip), basally firm and membranous at the tip; lower glume 9–18 mm long, 3-nerved in lower part; upper glume 8–14 mm long, 5–7-nerved in lower part. *Floret* fusiform to turbinate, 5–7.5 mm long, with a neck. *Lemma* deep brown, 5-nerved and tightly convolute at maturity, smooth and shiny, except for an antrorsely scabrous dorsal patch on the neck, glabrous to very sparsely clothed with light brown, or dark brown hairs, denser along the margins; coma present, sparse in front, 1–1.7 mm long, angled distinctively upwards at the sides to meet at the back; lemma lobes absent. *Callus* 2–3 mm long, straight, the sericeous hairs light brown to coppery colour. *Awn* 45–125 mm long (relatively slender for its length), 0.23–0.3 mm wide near the base, twice bent; column 14–32 mm long, 7–18 mm to the first bend, scabrous or pubescent, hairs 0.1–0.3 mm long; bristle antrorsely scabrous. *Palea* subequal to the lemma, obtuse, glabrous or with sparse coppery hairs along the centre or apex only. *Lodicules* 3; abaxial lodicules membranous, c. 1 mm long, spatulate; paleal lodicule present, much smaller than the abaxial lodicules. *Anthers* unpigmented, dwarfed, 0.6–0.7 mm long. *Style* glabrous. *Caryopsis* 2.5–3 mm long, embryo 25–35% the length; hilum 65–75% the length. (Figure 13A–C)

Diagnostic features. Differs from *A. lanata* in the palea being entirely enclosed by the lemma throughout development, the lemma and palea being usually sparsely hairy, or rarely both glabrous, and at least some ligules >> 2 mm long. Differs from other species with twice-bent awns and dark brown lemmas and lemma hairs by the smooth and shiny lemma and palea surfaces and the leaf sheath margins, auricles and ligules bearing very long and crinkly-woolly hairs.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 29 Sep. 1992, *G.J. Keighery* 13122 (PERTH); 25 Oct. 2000, *M.N. Lyons & S.D. Lyons* 3409 (CANB *n.v.*, PERTH); 23 Nov. 1997, *W. O'Sullivan* WOS 301 (PERTH); 23 Nov. 1997, *W. O'Sullivan* WOS 303 (PERTH). SOUTH AUSTRALIA: N of Tarcoola – Bulgunnia, 15 Apr. 1998, *R.J. Bates* 50171 (AD); 28 Sep. 1998, *R.J. Bates* 51079 (AD); Island in *s. dat.*, *D.J. Duval* 1588 (AD); 9 Nov. 2005, *M.K. Jones* 112 (AD); 24 Oct. 1998, *D.E. Murfet* 3362 (AD); 28 Oct. 2010, *H.P. Vonow* BS721-403 (AD). NEW SOUTH WALES: 25 Nov. 1980, *J. Everett* 132 (NSW); 12 Dec. 1985, *S.W.L. Jacobs* 4625 (NSW); 9 Dec. 1986, *R.F. Parsons* 606 (NSW); 3 Dec. 1975, *R.J. Stanley* 1784 (NSW). VICTORIA: 17 Dec. 1986, *J.H. Browne* 409 (AD *n.v.*, CANB, HO *n.v.*, MEL *n.v.*, NSW *n.v.*); 21 Feb. 1991, *G. Burnell s.n.* (MEL); 23 Oct. 2007, *J.A. Jeanes* 1715 (AD *n.v.*, CANB *n.v.*, MEL); 4 Dec. 2007, *I.R.K. S[luiter]* 08/06 (MEL).

Phenology. Flowers from June to October, fruits mature from late spring to early summer.

Distribution and habitat. Inland saline areas of eastern Western Australia through to western New South Wales and Victoria (Figure 13H). Grows on low rises (Kopi dunes) around gypsum salt lakes.

Conservation status. Recently listed as Priority Three (Western Australian Herbarium 1998–) under Conservation Codes for Western Australian Flora. Widespread across southern inland parts of the continent but not common. Few localities are known for Western Australia.

Etymology. The epithet was chosen by the original authors to honour their eminent mentor Dr Joyce Vickery MBE, (1908–1979), pioneer female botanist, conservationist, and Australian grass specialist, forensic scientist, and journal editor at the New South Wales National Herbarium, Royal Botanic Gardens, Sydney (Hooker 2002). Having personally benefitted from Dr Vickery's expertise in my early career I also wished to honour her memory in this instance.

Affinities. Considered by the original authors to be most similar to *A. eremophila* (of the *Eremophilae* group), but later placed in the *Lanterna* group.

D. *Tuberculatae* group (previously *Austrostipa* subg. *Tuberculatae* S.W.L.Jacobs & J.Everett)

The glossy tuberculate lemma surface of *A. burgesiana* undoubtedly places it in the *Tuberculatae* group, but this group has no other representatives in WA. All other species occur on the eastern side of the continent, including eastern Tasmania, with the nearest known occurrence being about 2,000 km away east of Adelaide in South Australia.

9. *Austrostipa burgesiana* A.R.Williams, sp. nov.

Typus: ‘Mt Burgess’ Station [Mt Burges Station], Western Australia [precise locality withheld for conservation reasons], 3 December 2013, A.A. Mitchell & P.J. Waddell 10499 (*holo*: PERTH 08552363; *iso*: AD n.v., BRI n.v.).

Austrostipa sp. Mount Burgess (A.A. Mitchell & P.J. Waddell 10499), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 12 July 2021]

Robust, erect, perennial *tussock grass*, branching extravaginally, 800–1000 mm tall. *Culms* unbranched, not geniculate, glabrous, c. 2 mm wide at the base; nodes 4 or 5, glabrous, exserted. *Leaf sheaths*: basal ones c. 2.5 mm wide, hirsute; upper ones glabrous, c. 1.2 mm wide. *Ligules* 0.5–1.0 mm long, acute, densely ciliate on margins and abaxially; adaxial surface glabrous. *Auricles* present, with a small tuft of hairs, c. 0.3 mm long. *Leaf blades* 70–120 mm long, lower ones hirsute, upper ones glabrous, rolled, c. 0.3 mm wide. *Panicle* narrow, c. 20 mm wide, 150–250 mm long, involucre a glabrous ridge, spikelets few and densely clustered at the lower nodes, on branches too short (≤ 40 mm long) to overlap the internodes (c. 50 mm long); minimum undivided branch length 1 mm, maximum undivided branch length 7 mm; maximum branch length 40 mm long (including glumes) scabrous on the edges. *Spikelets* 13–18 per node, 10–11 mm long. *Glumes* subequal, acuminate, translucent, glabrous, prominently 3-nerved; upper glume 10–11 mm long, lower glume 9–10 mm long. *Floret* turbinate, 4.5–5.5 mm long (including the callus), sericeous with sparse brown hairs except for the glabrous shoulder region. *Lemma* dark brown, tuberculate all over, glabrous in the upper 0.5 mm exposing the tuberculate shoulder surface. *Callus* c. 1.3 mm long, sericeous with hairs c. 0.3 mm long. *Lemma* margins overlapping in the mature floret. *Awn* column plumose in the lower part (hairs c. 0.5 mm long) tapering to scabrous (c. 0.05 mm long) in the upper part, twice bent, 5–7 mm to the first bend, 6–7 mm to the second bend, c. 0.25 mm wide at the base; bristle 23–25 mm long, scabrous; total awn length 34–38 mm. *Palea* glabrous. *Lodicules* not seen. *Anthers* not seen (apparently shed during anthesis). *Style* glabrous. *Caryopsis* c. 2.7 mm long but immature; embryo and hilum underdeveloped and not yet visible. (Figure 14A–C & E)

Diagnostic features. Differs from all other WA species in its unique combination of the lemma surface being glossy and rough (tuberculate) due to silica bodies that shatter when scraped with the edge of a scalpel blade, its distinctively reduced panicle structure and its densely pubescent ligules bearing conspicuously white hairs.

Phenology. Flowers late spring with fruit maturing in early summer.

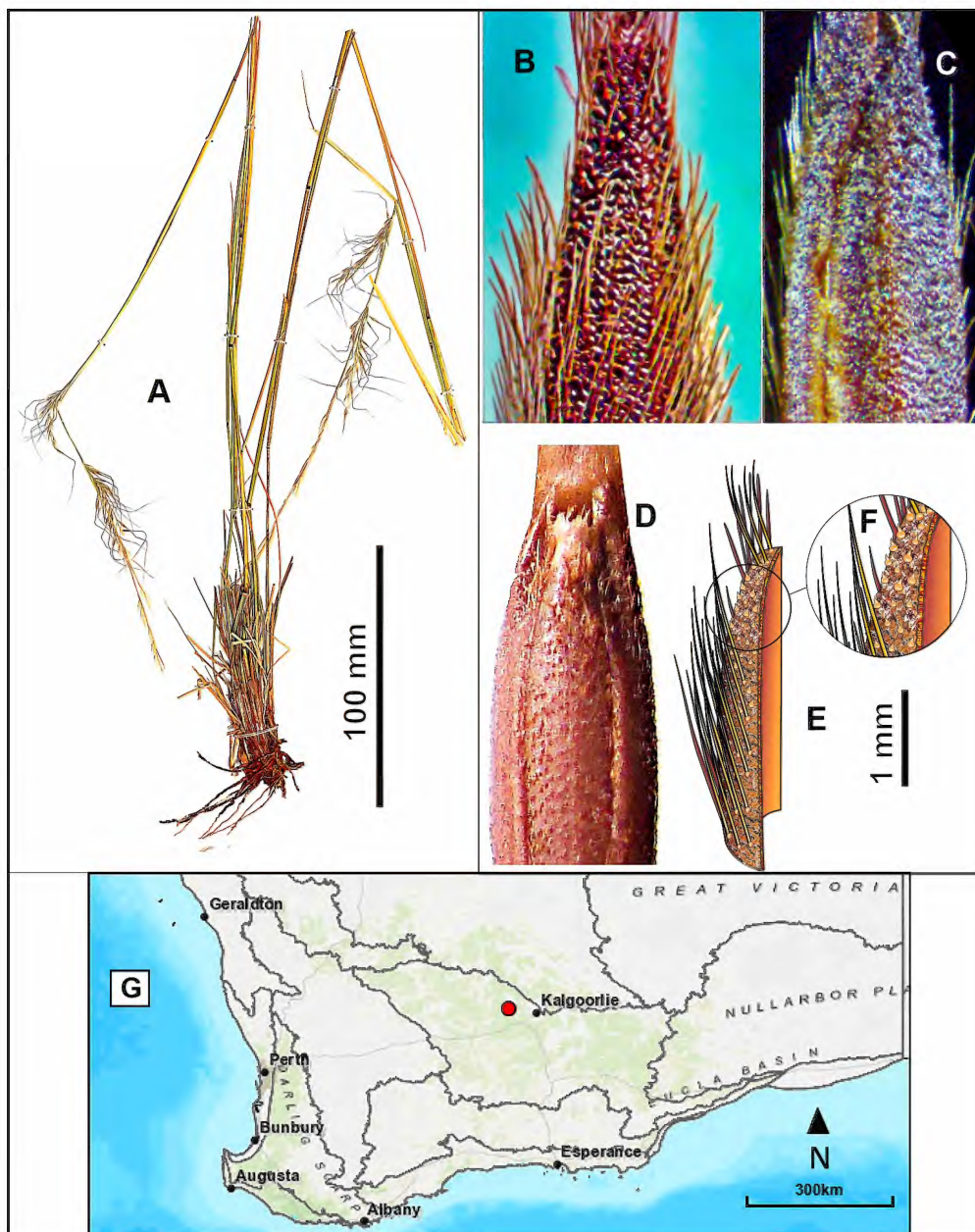


Figure 14. *Austrostipa burgesiana* and a single image of an *A. eremophila* floret. A – image of whole mature plant of *A. burgesiana*; B – image of floret shoulder region showing lemma surface entirely covered with glossy silica tubercles; C – same region of lemma surface after scraping with a scalpel blade, the fractured silica bodies creating the whitish colour showing that the entire surface has been damaged; D – upper lemma and palea surface of *A. eremophila* floret after being scraped with a scalpel blade in the same way showing that hairs have been shaved off leaving the lignified surface cells undamaged; E – schematic diagram of the lemma shoulder region of *A. burgesiana* with magnified section (F) showing a variety of different silica features that are not easily resolved with a light microscope; G – location of population (●). Items B–E are all at the same scale. Images and vector illustrations by the author based on A.A. Mitchell & P.J. Waddell 10499 (A–C, E), and T.E.H. Aplin 1662 (D).

Distribution and habitat. Only known from a single collection near Mt Burges Station homestead (Figure 14G), in the Southern Goldfields of the Coolgardie bioregion, where it was an infrequent component of a *Maireana pyramidata* shrubland on a flow line within a calcareous plain.

Conservation status. Recently listed as Priority One (Western Australian Herbarium 1998–) under Conservation Codes for Western Australian Flora under the phrase name *Austrostipa* sp. Mt Burgess (A.A. Mitchell & P.J. Waddell 10499).

Etymology. This species is named for Mt Burges Station, where the only known specimen was collected, but is also an acknowledgment of my heritage. A 'burgess' in English, from medieval times, referred to a free citizen of a town or borough, sometimes a landowner with merchant and voting rights, or to a representative of such in local government or in the national parliament. The surname Burgess (or Burges) thus carries the sense of ordinary people being good citizens, including my maternal grandfather, Edward Burgess, and my mother Mavis.

Affinities. Key differences from other species within the *Tuberculatae* group include the following: lemma hairs not restricted to nerves (this excludes *A. oligostachya*); culms erect (this excludes *A. muelleri*); spikelets > 12 per inflorescence (this excludes *A. nivicola*); leaf blades intact at flowering (this excludes *A. aphylla*); glumes tapering to a fine acuminate tip (this excludes *A. rudis*, *A. pubescens* and *A. pubinodis*). The nearest match in the *Flora of Australia* key is to *A. aphylla* in that the leaf blades in both species are extremely narrow and rather short for such a robust plant (perhaps withering prior to falling?). However, *A. aphylla* only occurs in eastern Tasmania and it differs from *A. burgesiana* in numerous other features. The likely nearest related WA group, *Eremophilae*, can be distinguished on the following characters. The lemma surface in *Eremophilae* is smooth and dull brown, not glossy and tuberculate, and the upper 0.5 mm is not glabrous but bears a distinct patch of short hairs; mature lemma hairs in *Eremophilae* are a much darker rich brown colour. The panicle in *Eremophilae* is not contracted, with few spikelets on short branches clustered at the nodes; it is more symmetrically broad and more open with evenly distributed spikelets. Awn column hairs in *Eremophilae* are of even length throughout.

Notes. Tubercles and tuberculate hairs can be seen under a microscope but may be unfamiliar to those working with WA species of *Austrostipa*. A convenient technique for uniquely identifying them is to scrape the hairs off the lemma with the edge of a sharp scalpel blade. The tubercles readily shatter and at least some of the dislodged hairs will retain a fragment of the fractured tubercle at their base. However, the most obvious result is that the bared lemma surface is left covered with disrupted tubercles, which take on a whitish appearance due to reflection and refraction of light from the fractured silica, clearly distinct from the undisturbed dark brown lemma surface in the background (Figure 14C). When hairs are scraped off the mature lemmas of other WA species, they usually come off cleanly at the base, leaving the hard, lignified, lemma surface without any damage or discoloration, as in *A. eremophila* (Figure 14D).

2. *Austrostipa* subg. *Falcatae* S.W.L.Jacobs & J.Everett

Falcatae S.W.L.Jacobs & J.Everett is a large subgenus in *Austrostipa* that occurs right across southern Australia. The taxonomic history of some species within *Falcatae* has been complex and remains controversial, as noted below. Amongst published molecular studies relevant to subgenus structure within *Austrostipa* both Syme *et al.* (2012) and Syme (2012) managed to obtain a reasonably meaningful picture with ITS sequence comparisons, and both identified *Falcatae* as being monophyletic, with all eight taxa (out of 31 in the study) grouped together into a single clade. Winterfeld *et al.* (2015) used

cytogenetic data mapped onto molecular phylogenetic trees based on nuclear ITS and chloroplast 3' *trnK* DNA sequence data and likewise found *Falcatae* to be a distinctively monophyletic group.

Three new species are described and illustrated here: *Austrostipa nunaginis* (*A.* sp. Cairn Hill) known from seven sites in the northern wheatbelt (Greenough to Bruce Rock), *A. frankliniae* (*A.* sp. Dowerin) known from three populations in the east-central wheatbelt (Dowerin to Coolgardie), and *A. anaiwaniorum* (*A.* sp. Marchagee) quite widely collected but previously included under the name *A. tenuifolia*.

Vickery *et al.* (1986) recognised a lot of variation in the members of this subgenus, and their main points are still relevant, given below in quotes. *Austrostipa nitida*, the type species for the genus, 'is a very variable species. ... The auricles ... vary from glabrous to woolly, with no detectable pattern that we could correlate with variation in other characters. There is similar variation in other vegetative characters.' They cited 15 specimens that 'all have broad leaves and sheaths' and said 'Other such groups of specimens can be separated from [*A.*] *nitida* but we have been unable to detect any reliable pattern in the variability. Clearly this large species and its many forms would be worthy of further studies.' Hughes (1921) is cited as having confused *A. nitida* with *A. scabra*.

'The identity and circumscription of [*Austrostipa*] *falcata*, treated here as [*A.*] *scabra* subsp. *falcata*, have been a source of considerable confusion in Australian herbaria where many other species have been misdetermined under this name'—Hughes, Black and Bentham are cited. 'In foliage, appearance of the rootstock, glumes, indumentum and dimensions of the lemma and column, the two subspecies are much alike.' They identified the inflorescence shape and the ligule as the differentiating characters. However, they then admitted 'There are some intermediates between the subspecies that have the inflorescence type of one subspecies but the ligule type of the other' and cited 10 examples.

Regarding *Austrostipa tenuifolia* they said it 'is similar to *A. variabilis* but differs in the longer floret and awns and the longer, usually unequal glumes.' In their written descriptions, the awn lengths of these two species overlap and several specimens of *A. tenuifolia* in our collection that were determined by Vickery and/or Everett have florets in the 6–7 mm range, overlapping that of *A. variabilis*.

Regarding *A. variabilis* they said, 'The specific epithet has been applied to a range of species (nearly all of the *Falcatae*) by Australian collectors and authors in recent years, and their identifications and descriptions must be regarded with caution.' They then attempted to clarify the situation by stating that '*S. variabilis* is characterised by a floret 4.5–7 mm long and a densely pubescent column of the awn.' In their written descriptions we find that all but *A. tenuifolia* fit the floret size range (and, as mentioned previously, several specimens of *A. tenuifolia* in our collection determined by them have florets in the 6–7 mm range), and *A. trichophylla* and *A. tenuifolia* can both have "densely pubescent" and *A. nitida* can have 'pubescent' columns.

They made no specific comments on *A. trichophylla*, *A. nodosa*, or *A. drummondii* so we could infer that these species fit well within their descriptions. However, we have already seen that *A. trichophylla* overlaps with *A. variabilis*, and in their written descriptions *A. nodosa* and *A. drummondii* overlap at least some of the other species in virtually all characters used.

Jessop *et al.* (2006) found similar problems with character variability and offered the following advice with their key to the South Australian species. 'This key must be used with caution. Many species

overlap in their characters more than implied by Vickery, Jacobs and Everett and absolutely reliable characters are sometimes hard, if not impossible, to find.’ ‘Specimens apparently intermediate with *A. nitida* and *A. scabra* are particularly common. Less frequent problems occur with distinguishing it from *A. drummondii*, which is usually recognisable by its thick and often short leaves and characteristic indumentum. An isotype of *A. nitida* in AD has leaves which are closer to *A. scabra* in width than to *A. nitida*.’ ‘*A. nodosa* merges with both *A. nitida* and *A. scabra*. The often-exposed culm nodes, the sparse panicle and the leaf breadth provide characters for separating *A. nodosa*, but many specimens cannot be identified with certainty.’ Regarding the two subspecies of *A. scabra* ‘A large number of specimens cannot be placed with any certainty and users may prefer to ignore the subspecies. There is also a problem in distinguishing *A. scabra* from a number of other species ... especially *A. nitida*. The large number of very narrow, very straight leaves is immediately recognisable on many specimens, but intermediates do occur. It has been decided to treat specimens formerly identified as *A. variabilis* in this species. [They] were [originally] described from opposite ends of the continent and separated in their key by Vickery [*et al.*] (1986) on the length of the hairs on their columns. ... this character is not very reliable.’ Regarding *A. trichophylla* ‘[they] give the column hairs as usually 0.15–0.3 mm long, yet in their key it is allocated to the group with [column] hairs 0.25–0.8 (as opposed to [those with] 0.2 mm long or less). ... specimens identified by one of them show that the hairs may even be about 1 mm long.’

Jessop *et al.* (2006) recorded no difficulties with *A. tenuifolia*. However, I discovered that in our PERTH collections of *A. tenuifolia* there were two mutually exclusive kinds of collar regions (i.e. specimens either had one type or another, with no intermediates) as illustrated in Figure 15C compared with Figure 18C. Type specimens for *A. tenuifolia* were found to be all of the latter kind (as in Figure 18C) so I have segregated specimens with the alternative kind (Figure 15C) into a new species *A. anaiwaniorum*. The new species is quite abundant in WA and its geographic range is similar to that of *A. tenuifolia*, but it does not extend as far eastward, as illustrated in Figure 15D. Removal of *A. anaiwaniorum* from within *A. tenuifolia* required a revision of the description of *A. tenuifolia*, which is given below.

The descriptions of *A. tenuifolia* in Vickery *et al.* (1986) and in the *Flora of Australia* (Everett *et al.* 2009) both say that the abaxial surface of the ligule can be either hairy or glabrous, and the authors identified specimens of both kinds among the PERTH collection as being ‘*Stipa*’ *tenuifolia*. The key character used to separate this taxon from *A. blakei* in Vickery *et al.* (1986) was: ‘Auricles hirsute with a dense line of long white hairs,’ but this character is not present on any of their cited type specimens, which all lack an auricle. Their synonymy included six previously named taxa based on four Drummond collections from Western Australia and their discussion of synonymy was quite complex, indicating a fair amount of confusion amongst different workers at earlier times. Of particular interest to the present article is their lectotypification of *Drummond* 4: 391 as the type for *Stipa scabra* var. *occidentalis* Benth. (thus making it now an isotype specimen for *A. tenuifolia*) and their explicit rejection of *S. puberula* as a possible synonym. The present analysis indicates that *A. anaiwaniorum* does have some affinities with *A. puberula*.

I have not followed Jessop *et al.* (2006) in their inclusion of *A. variabilis* within *A. scabra*, because the distinction remains useful, if sometimes uncertain, within our PERTH collections. This may be relevant to a comment made by Vickery *et al.* (1986) that the holotype as well as the majority of their specimens came from WA and perhaps *A. variabilis* was ‘a recent introduction to South Australia’. However, the broader question remains as to how the pervasive variability across this

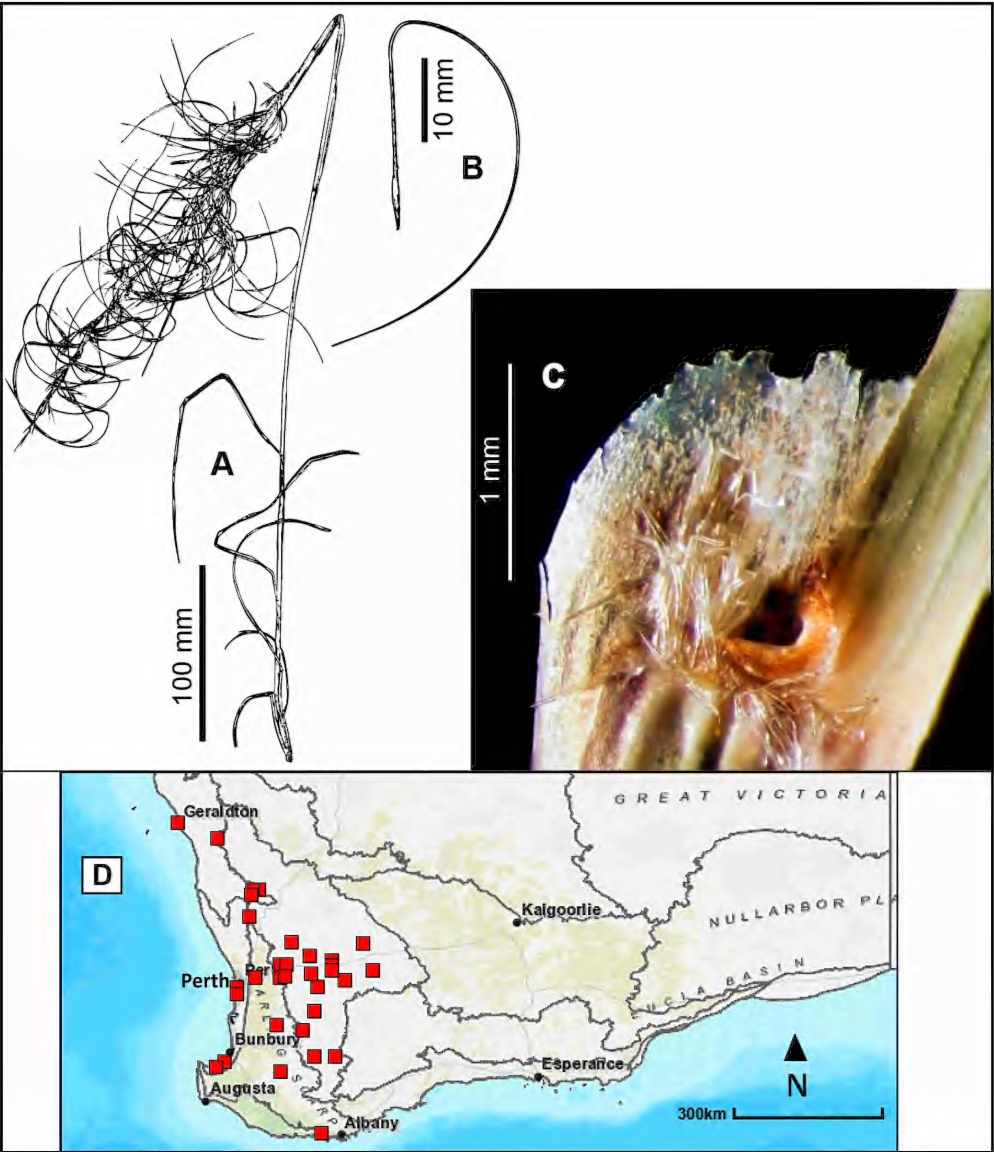


Figure 15. *Austrostipa anaivaniorum*. A – vector outline of a single flowering culm; B – vector outline of typical floret with straight awn column and falcate bristle; C – image of collar region with glabrous ligule and leaf sheath margin, and the well-developed auricle with its distinctive line of large hairs running underneath it; D – distribution of *A. anaivaniorum* (■). Illustrations by the author based on *A. Despeissis* s.n. PERTH 00481831 (A, B), and *U. Bell* 393 (C).

entire subgenus should be dealt with. I have found that the existing published species descriptions (except as described in this article for *A. tenuifolia*) are generally useful for practical purposes until more advanced methods of determination become available.

10. *Austrostipa anaiwaniorum* A.R. Williams, *sp. nov.*

Typus: near 156 mile peg on Geraldton Highway [now Midlands Road] (c. 4 miles south of Marchagee), Western Australia, 20 October 1970, B.R. Maslin 1407 (*holo*: PERTH 00481629).

Austrostipa sp. Marchagee (B.R. Maslin 1407), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au> [accessed 22 July 2021].

Perennial *tussock grass*, 600–1000 mm tall with a basal tuft of leaves. *Culms* terete, unbranched, 2–3 mm wide near the base, erect or geniculate at the base, shoots intra- or extra-vaginal, glabrous, scaberulous or puberulous; nodes 3–5, mostly enclosed, thickened, glabrous. *Leaf sheaths* loosely enveloping the culm, 2–5 mm wide at the base; lower ones glabrous or pubescent, margin glabrous or ciliate; upper ones 1–3 mm wide, glabrous, with glabrous margins. *Ligules* truncate or ovate, entire, coriaceous, 0.5–1 mm long, margin glabrous, entire; abaxial surface glabrous, continuous with the glabrous sheath margin. *Auricles* conspicuous, with an adjacent conspicuous horizontal line of hairs 1–2 mm long which sometimes encircles the collar. *Leaf blades* green at flowering time, in-rolled, erect, 75–200 mm long, 0.5–1 mm wide, margins glabrous; abaxial surface unribbed or ribbed, glabrous, scabrous or hirsute; adaxial surface strongly ribbed, hirsute with hairs c. 0.3 mm long. *Panicle* exserted, 300–400 mm long, 30–40 mm wide, spreading; axis terete, scabrous, usually compact with closely-spaced fascicles of few-flowered branches; branches 50–80 mm long, terete, scabrous; pedicels terete 15–25 mm long, scabrous or scaberulous. *Spikelets* 14–20 mm long, gaping, subequal or unequal, acuminate, either membranous or firm, purple-tinged. *Glumes* glabrous or scabrous; lower glume 14–20 mm long, 3–5-nerved in lower part; upper glume 12–17 mm long, 3–5-nerved in lower part, 3-nerved in upper part. *Floret* linear, 6.5–9 mm long, with a neck, granular surface becoming tuberculate below the apex, dark brown at maturity. *Lemma* hairs white, erect and spreading, sparse, glabrous below the apex; lemma lobes 1 or 2, 0.1–0.2 mm long; coma 0.6–0.8 mm long. *Callus* straight, 2.0–2.5 mm long, the hairs white or yellowish. *Awn* 70–100 mm long, 0.3–0.4 mm wide near the base; column straight, 13–16 mm long, pubescent or plumose with hairs 0.2–0.5 mm long; bristle falcate, scabrous with hairs 0.1–0.2 mm long, triangular in cross section, no broader than column. *Palea* subequal to the lemma, margins and tip membranous and glabrous. *Lodicules* 2 or 3; abaxial lodicules blunt, 0.8 mm long, paleal lodicule acute, 2 mm long. *Anthers* penicillate or not, 1.0–3.5 mm long. *Style* glabrous. *Caryopsis* 3.8–5 mm long; embryo 0.7–1.6 mm long; hilum 3–3.3 mm long. (Figure 15A–C)

Diagnostic features. Differs from *A. tenuifolia* in having a straight awn column and a collar region with a glabrous ligule and leaf sheath margin and a well-developed auricle with a distinctive line of large hairs running underneath it.

Other specimens examined. WESTERN AUSTRALIA: corner Eagle and Walker Streets, Mundaring, 2 Nov. 2000, *U. Bell* 331 (PERTH); Yarragil Valley, Mundaring, 3 Dec. 2001, *U. Bell* 393 (PERTH); NE corner of Yarragadee Road and Depot Hill Road, Yarragadee, 3 Sep. 2004, *U. Bell* 514 (PERTH); Reserve 27092, Bay Street–Drove Street, Katanning, 14 Nov. 2009, *U. Bell* 594 (PERTH); Reserve 27092, Bay Street–Drove Street, Katanning, 14 Nov. 2009, *U. Bell* 596 (PERTH); Bay/Drove Street Bush Res. 27092, Katanning, 16 Dec. 2011, *U. Bell* 618 (PERTH); Buller River, N of Geraldton, 2 Sep. 1947, *S.T. Blake* 18080 (BRI, K, NSW *n.v.*, PERTH); E of Lakes turnoff towards York, Wambyrn

Nature Reserve, 9 Oct. 1998, *R. Davis* 7249 (PERTH); NE of Dinninup, c. 55 km NE of Bridgetown, 28 Oct. 1998, *R. Davis* 8245 (PERTH); Oak Park Shire Reserve approx. 18 km NNE of the town of Goomalling, 18 Sep. 1999, *A.G. Gunness et al. s.n.* (PERTH); site 109, B. & W. Davey property, S of Youndeggin-Kelkering Road, S of Cunderdin, 1 Oct. 2003, *M. Hislop & M. Griffiths* WW 109-17 (PERTH); Northern slopes of Mount Brown, Shire of York, 30 Sep. 2004, *M. Hislop & M. Griffiths* WW 145-26 (AD *n.v.*, PERTH); Bush remnant c. 25 km N of Cunderdin, 20 Oct. 1997, *B.J. Lepski, T.R. Lally & W.H. Treasure* BJL 3580 (PERTH); Tronox Cooljarloo Minesite, 6 Oct. 2016, *B. Loudon* 92C-05-01 (PERTH); Lake Coomelberrup, 43 km ESE of Wagin, SAP wetlands site SPM014C, 11 Nov. 2000, *M.N. Lyons & S.D. Lyons* 3850 (PERTH); saline pan, 13.5 km ENE of Gunyidi, SAP wetlands site SPS158H, 5 Oct. 2000, *M.N. Lyons, S.D. Lyons* 3851 (PERTH); Salt River, 7.5 km S of Kellerberrin, SAP wetlands site SPS208C, 13 Oct. 2000, *M.N. Lyons & S.D. Lyons* 3855 (PERTH); Granite walk, Foxes Lair, 18 Oct. 2005, *P. Rose* 434 (PERTH); Lake Banganup, Jandakot, 2 Nov. 1974, *A.S. Weston* 9798 (CANB, PERTH); 15 km NNW of Kellerberrin, 23 Sep. 2008, *G. Wiehl* F 8022 (PERTH).

Phenology. Flowering from mid-winter to early spring. Fruiting from mid-spring to late summer.

Distribution and habitat. Occurs in the Geraldton Sandplains, Jarrah Forest, Avon Wheatbelt and Swan Coastal Plain bioregions (Figure 15D).

Conservation status. Widespread and common, similar in distribution and habitat to *A. tenuifolia*.

Etymology. The epithet is in recognition of the Northern Anaiwan people, original custodians of the land where I was born in northern New South Wales, where I grew up, and where I first studied and then practised as a botanist. The name is registered as item D64 in the AIATSIS language catalogue: <https://collection.aiatsis.gov.au/austlang/language/d64>.

Affinities. Previously included in *A. tenuifolia* which is similar in most floral and vegetative characters but has an entirely different collar region as illustrated in Figure 15C compared with Figure 18C and a different awn structure. *A. tenuifolia* has a dense mass of white hairs on the abaxial surface of the ligule, which is not continuous with a sheath margin, but in this species the abaxial surface of the ligule is glabrous, and it is continuous with a broad glabrous sheath margin. *A. tenuifolia* usually has no auricle and is glabrous in the region where the auricle could be, but this new species has a well-developed auricle and it has a dense line of hairs of an entirely different kind to those on the ligule of *A. tenuifolia*, being broader, longer, and transparent. The falcate awn in *A. tenuifolia* has an exaggerated terminal curve on the column which can sometimes make it look like the column is twice bent, but in *A. anaiwaniorum* the bristle is strictly falcate from the end of a straight column. There are also differences in basal sheath indumentum, culm indumentum below the nodes, and distinctive features of the panicle nodes.

11. *Austrostipa frankliniae* A.R.Williams, *sp. nov.*

Typus: Lake Campion Nature Reserve, Western Australia [precise locality withheld for conservation reasons], 7 October 2012, *A. Dooley* AD 427 (*holo:* PERTH 08449252).

Austrostipa sp. Dowerin (G. Wiehl F 8004), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au> [accessed 13 February 2012].

Perennial *tussock grass*, 250–400 mm tall with a basal tuft of leaves. *Culms* terete, unbranched, 3 mm wide near the bulbous base, not geniculate, glabrous; nodes 1–3, enclosed, thickened, glabrous. *Leaf sheaths* loosely enveloping the culm, 1.5–2 mm wide above the bulbous base; lower ones densely hirsute with crinkly hairs, margin glabrous; upper ones 1–1.5 mm wide, glabrous, margin hirsute around the mouth. *Ligules* 0.2–0.3 mm long, shape obscured by the abundance of abaxial hairs, continuous with the sheath margin. *Auricles* absent, but sheath apex with dense tuft of white hairs *c.* 1 mm long. *Leaf blades* partly green at flowering time, distinctively curved so that they make circular patterns, 120–160 mm long, 0.4 mm wide; abaxial surface unribbed, glabrous or minutely scaberulous; adaxial surface strongly ribbed, scabrous. *Panicle* enclosed, 100–250 mm long, 30–50 mm wide, contracted, axis terete, scabrous, sparse with few-flowered branches 40–80 mm long, terete, scabrous; pedicels terete, 3–40 mm long, scabrous or scaberulous. *Spikelets* 13–17 mm long, gaping, unequal, acuminate, membranous. *Glumes* glabrous; lower glume 13–17 mm long, 3-nerved in lower part; upper glume 11–13 mm long, 5-nerved in lower part. *Floret* lanceolate, 4.7–7.5 mm long, with a neck, brown at maturity, with finely granular and glossy surface. *Lemma* brown, with brown hairs, and a bare patch in the shoulder region revealing the glossy scabrid lemma surface (sometimes becoming tuberculate on the neck); lemma lobes 0.2–0.3 mm long; coma 0.6–0.8 mm long. *Callus* straight, 1.4–2.5 mm long, the hairs distinctively white, pale, or the same colour as the lemma. *Awn* 70–100 mm long, *c.* 0.4 mm wide near the base; column straight, 10–12 mm long, scabrous with hairs 0.1–0.2 mm long; bristle falcate, scabrous with hairs 0.1–0.2 mm long, triangular in cross section, no broader than column. *Palea* subequal to the lemma and enclosed by it. *Lodicules* 2 or 3; abaxial ones blunt, 0.5 mm long, paleal one acute 0.5 mm long. *Anthems* not penicillate, dwarfed and non-pigmented, only one fertile; anterior one sparsely fertile, 0.8–0.9 mm long; posterior ones sterile, 0.4–0.5 mm long. *Style* glabrous. *Caryopsis* 3.5–4 mm long; embryo 1–1.25 mm long; hilum 2.5–3 mm long. (Figure 16A–D)

Diagnostic features. This species is unique in three ways: (1) falcate awns with brown lemma hairs (all other members of this subgenus have white lemma hairs); (2) strongly curved leaf blades that create circular patterns (other species have straight, gently curved, or flexuose leaf blades); (3) the long crinkly hairs covering the densely hairy basal sheaths are also unique in this subgenus (but do occur in the *Lanterna* group of subsp. *Austrostipa*).

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 26 Nov. 2011, *A. Dooley* AD 291 (PERTH); 7 Oct. 2012, *A. Dooley* AD 424 (PERTH); 7 Oct. 2012, *A. Dooley* AD 425 (PERTH); 7 Oct. 2012, *A. Dooley* AD 426 (PERTH); 7 Oct. 2012, *A. Dooley* AD 427 (PERTH); 11 Oct. 2011, *R. Meissner* & *R. Coppen* 3868 A (PERTH); 14 Oct. 2011, *R. Meissner* & *R. Coppen* 3870 (MEL, PERTH); 21 Oct. 2008, *G. Wiehl* F 8004 (PERTH).

Phenology. Flowering in spring. Fruiting late spring to early summer.

Distribution and habitat. Small populations have survived in reserves in the Avon Wheatbelt, Coolgardie and Yalgoo bioregions (Figure 16E).

Conservation status. *Austrostipa frankliniae* is listed by Smith and Jones (2018) as Priority Two under Conservation Codes for Western Australian Flora, under the name *A. sp.* Dowerin (*G. Wiehl* F 8004).

Etymology. Named in honour of Lady Jane Franklin (1791–1875), pioneer female naturalist and philanthropist, who founded the first botanic garden and natural history museum in Tasmania, and a society for the advancement of science that became the first Royal Society outside of Britain.

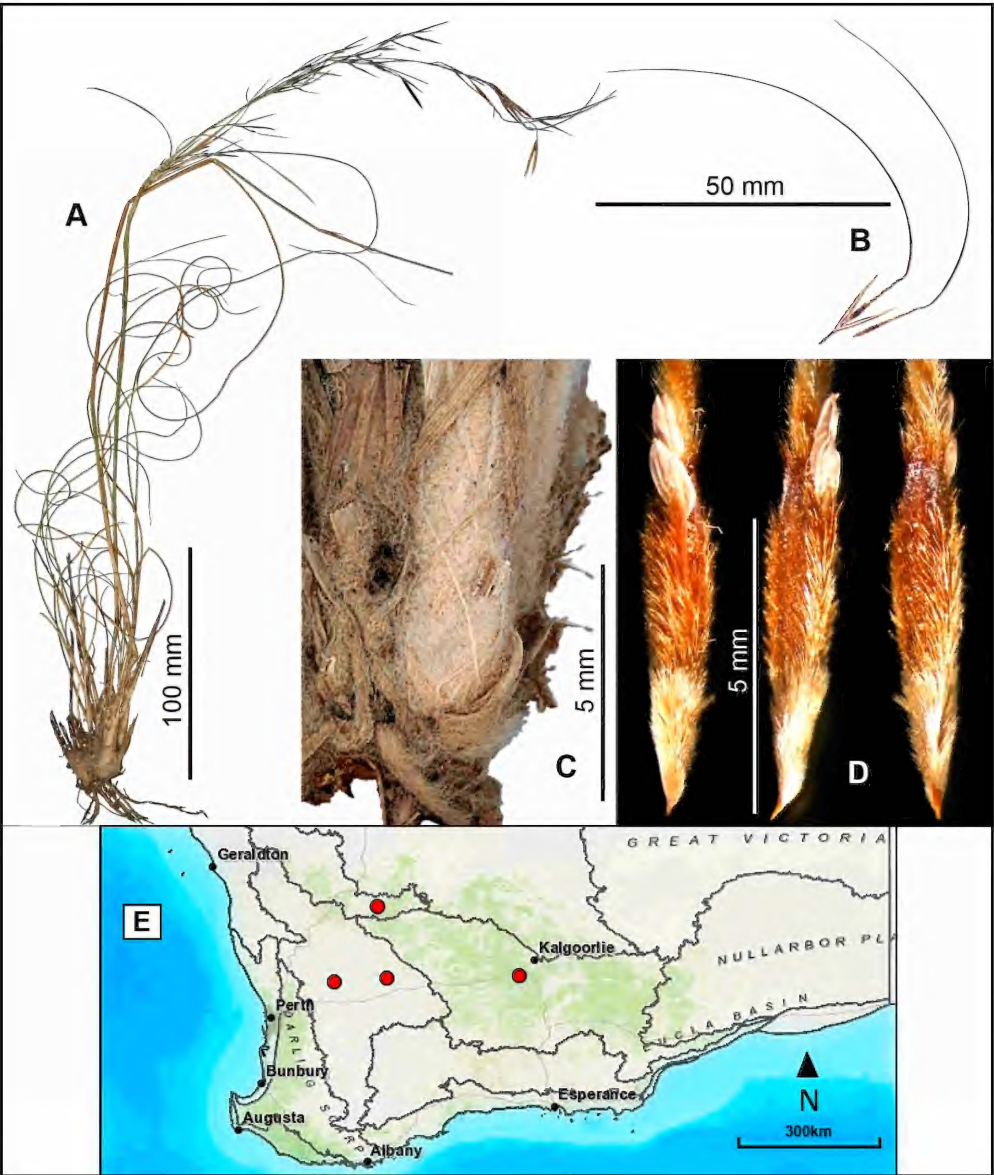


Figure 16. *Austrostipa frankliniae*. A – vector trace of mature whole plant showing its unique curly leaves; B – vector trace of spikelet and two florets; C – image of crinkly woolly culm bases; D – three different views of a single floret with its unique red-brown indumentum; E – distribution of *A. frankliniae* (●). Images by the author based on G. Wiehl F 8004.

Affinities. Molecular studies of *Austrostipa* (cited earlier) have consistently found that subg. *Falcatae* has a distinct monophyletic status, so the falcate awn of *A. frankliniae* is sufficient to place it in this subgenus; however, the three diagnostic features listed above set it apart from all other members of the subgenus.

12. *Austrostipa nunaginensis* A.R. Williams, *sp. nov.*

Typus: Warradarge [precise locality withheld for conservation reasons], Western Australia, 23 October 2011, B. Morgan BES 000102 (*holo:* PERTH 08460574).

Austrostipa sp. Cairn Hill (M.E. Trudgen 21176), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au> [accessed 12 July 2021].

Perennial tussock grass, 200–500 mm tall, with a basal tuft of leaves. *Culms* terete, unbranched, 1–2 mm wide near the base, geniculate, densely pubescent; nodes 3–5, enclosed early but becoming visible as sheath peels back, thickened, densely sericeous. *Leaf sheaths* loosely enveloping the culm, 2–5 mm wide at the base; lower leaf sheaths densely pubescent, margin ciliate; upper leaf sheaths 1–3 mm wide, glabrous, or pubescent. *Ligules* truncate or ovate, entire, coriaceous, 0.2–0.3 mm long, margin glabrous, entire; abaxial surface pubescent, continuous with the sheath margin. *Auricles* conspicuous, with hairs 1–2 mm long. *Leaf blades* green at flowering time, flexuose, 75–100 mm long, 0.5–1 mm wide, margins glabrous; abaxial surface ribbed, glabrous; adaxial surface strongly ribbed, hirsute with hairs 0.3 mm long. *Panicle* exserted, 100–200 mm long, 20–30 mm wide, spreading; axis terete, scabrous, usually sparse with moderately close fascicles of usually few-flowered branches; branches 30–80 mm long, angular, scabrous; pedicels flattened, 15–25 mm long, scabrous or scaberulous. *Spikelets* 11–13 mm long, gaping, subequal, acuminate, membranous, purple-tinged. *Glumes* glabrous or scabrous; lower glume 11–13 mm long, 3–5-nerved in lower part; upper glume, 10–12 mm long, 3–5-nerved in lower part, 3-nerved in upper part. *Floret* linear, 6.4–7.6 mm long, with a neck, surface finely granular but tuberculate below the apex, dark brown at maturity, the 3 main nerves slightly thickened at the apex. *Lemma* hairs white, erect and spreading, sparse, glabrous below the apex; lemma lobes absent or present, 0–0.2 mm long; coma 0.3–0.7 mm long. *Callus* straight, 2.0–2.5 mm long, the hairs white. *Awn* 70–80 mm long, 0.25–0.35 mm wide near the base; column straight, 11–14 mm long, scaberulous with hairs 0.02–0.03 mm long; bristle falcate, scabrous with hairs 0.1–0.2 mm long, triangular in cross section, no broader than column. *Palea* subequal to the lemma and enclosed by it, acute or obtuse, with a line of white hairs along the centre only, margins and tip membranous and glabrous. *Lodicules* 2 or 3; abaxial lodicules blunt, 0.8 mm long, paleal lodicule acute, 2 mm long. *Anthers* penicillate or not, 1.0–3.5 mm long. *Style* glabrous. *Caryopsis* 3.8–5 mm long; embryo 0.7–1.6 mm long; hilum 3–3.3 mm long. (Figure 17A–D)

Diagnostic features. The combination of minutely scaberulous awn column with densely hairy basal leaf sheaths and nodes with geniculate culms sets it apart from *A. nitida* and *A. scabra*.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] Oct. 1913, A. Baxter s.n. (PERTH); 9 Oct. 2006, K. Freeman 23 (PERTH); 25 Sep. 2007, C. Godden & K. Greenacre SLU 97-08 (PERTH); 12 Oct. 2006, C. Godden & G. Woodman GI-10-06 (PERTH); Oct. 1970, B. Greig 17 (PERTH); 4 Nov. 2001, M. Hislop 2370 (PERTH); 14 Sep. 2001, C. Howell 560 (MEL, PERTH); 7 Nov. 2017, B. Loudon W3-11-01 (PERTH); 17 Oct. 2014, B. Morgan & H. Ajduk DHR 9-1 (PERTH); 19 Nov. 2012, B. Morgan BMor 1379 (PERTH); 23 Oct. 2000, M.E. Trudgen MET 21176 (PERTH).

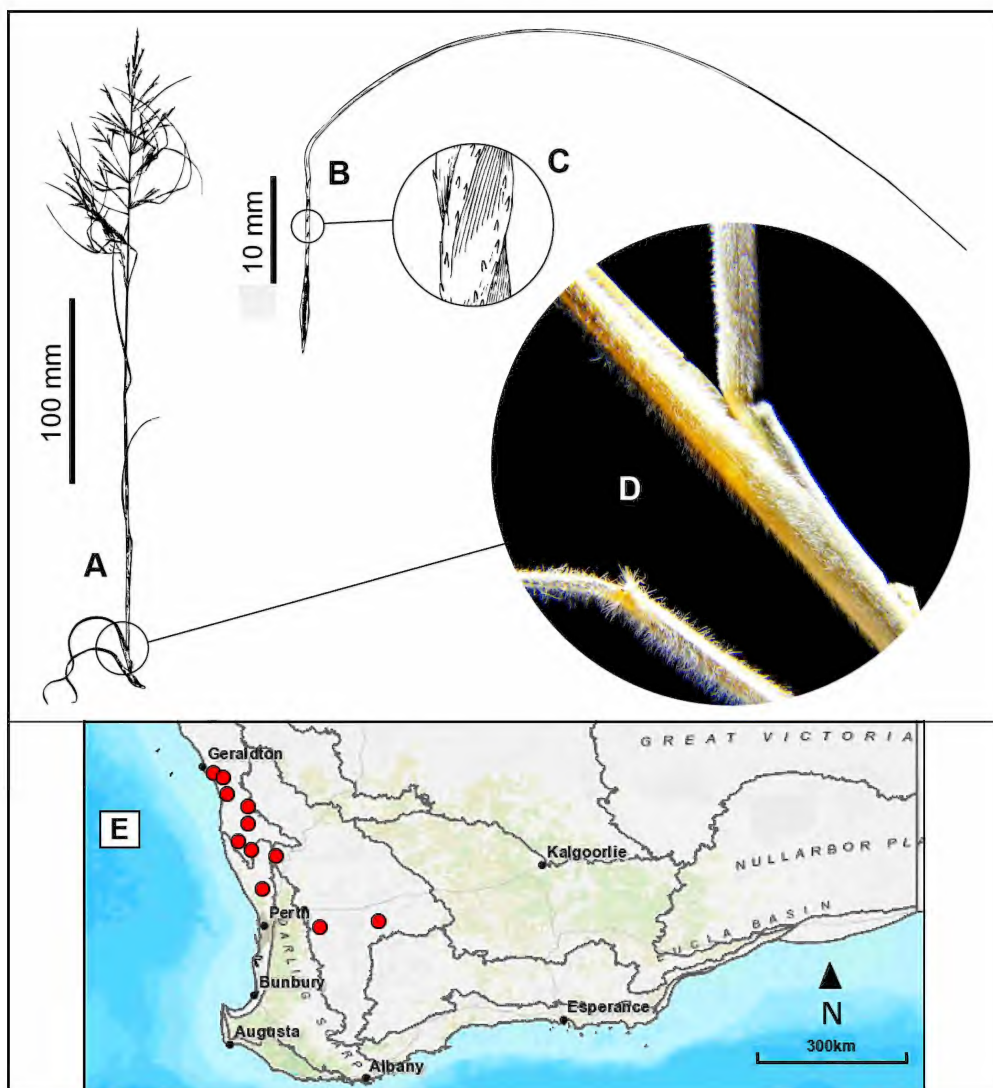


Figure 17. *Austrostipa nunaginensis*. A – vector outline of a mature single flowering culm; B – vector outline of a mature floret; C – vector illustration of a section of the distinctively scaberulous awn column; D – image of the densely hirsute culm base and leaf sheath; E – distribution of *A. nunaginensis* (●). Illustrations by the author based on M.E. Trudgen MET 21176.

Phenology. Flowering late spring, fruiting early summer.

Distribution and habitat. Occurs in the Geraldton Sandplains, Avon Wheatbelt and Swan Coastal Plain bioregions (Figure 17E).

Conservation status. *Austrostipa nunaginensis* is listed by Smith and Jones (2018) as Priority Three under Conservation Codes for Western Australian Flora, under the name *A. sp. Cairn Hill* (M.E. Trudgen 21176).

Etymology. The epithet is derived from the town of Nunagin (now called Bruce Rock), the location cited where it was first collected in 1913, the year that the town and the East Avon Road District were first gazetted.

Affinities. Similar to *A. nitida* and *A. scabra* but differs in having densely hairy basal leaf sheaths and nodes and geniculate culms.

13. *Austrostipa tenuifolia* (Steud.) S.W.L.Jacobs & J.Everett, *Telopea* 6: 589 (1996); *Stipa tenuifolia* Steud., *Syn. Pl. Glum.* 1: 128 (1854). *Type:* N. Holl [Western Australia], *Drummond* coll. IV. n. 391 (*holo:* P!; *iso:* K!, MEL 59997!).

Stipa scabra var. *occidentalis* Benth., *Fl. Austral.* 7: 571 (1878). *Type:* *Drummond* coll. IV. n. 391 (*lecto:* K!, *fide* J.W. Vickery, S.W.L. Jacobs & J. Everett, *Telopea* 3: 119 (1986)).

Perennial *tussock grass*, shoots conspicuously extravaginal, 600–1000 mm tall, with a basal tuft of leaves. *Culms* erect, or geniculate at the base, unbranched, 0.8–2.5 mm wide near the base; nodes 2 or 3, enclosed, thickened, glabrous, or indumented. *Leaf sheaths* tightly enveloping the culm, ribbed, outer margin ciliate; basal ones pubescent or villous; upper ones glabrous. *Ligules* truncate, or ovate, entire, coriaceous, 0.8–4 mm long; abaxial surface densely pubescent with conspicuous white hairs. *Auricles* absent or inconspicuous. *Leaf blades* green and purple-tinged at flowering time, erect, in-rolled, 0–30 cm long, 0.5–3 mm wide; abaxial surface unribbed, or slightly ribbed, scabrous, or hirsute; adaxial surface and margins scabrous. *Panicle* 250–350 mm long, exserted, usually sparse, occasionally denser, with moderately close fascicles of usually few-flowered branches, spreading, 50–70 mm wide; axis terete, scaberulous; branches terete, 50–100 mm long, scabrous; pedicels angular, 10–30 mm long, scabrous or scaberulous. *Spikelets* 13–24 mm long, gaping. *Glumes* subequal, or unequal, acuminate, membranous or firm, purple-tinged; lower glume 13–24 mm long, 3-nerved in lower part; upper glume 12–18 mm long, 5-nerved in lower part, 3-nerved in upper part. *Floret* linear, 6.5–9 mm long, with a neck. *Lemma* finely granular, sometimes tuberculate over the apex of the midvein; lemma hairs white, or sometimes brownish at maturity, sparse, sericeous, usually glabrous in the upper part, sometimes having a distinct collar of short hairs completely encircling the shoulder region; lemma lobes 1 or 2, 0–0.4 mm long; coma 0.6–1.5 mm long. *Callus* 2.1–3.1 mm long, straight, sericeous with hairs white or yellow. *Awn* 70–120 mm long, 0.25–0.45 mm wide near the base, falcate; column 10–22 mm long, 6–13 mm to the first bend, pubescent, or plumose, with hairs 0.15–1.3 mm long; bristle triangular, no broader than column, scabrous. *Palea* subequal to the lemma, or shorter than the lemma, not completely enclosed by lemma, with a line of white hairs along the centre only, the margins and tip membranous and glabrous. *Lodicules* 2, membranous, 1.4–1.8 mm long, spatulate. *Anthers* 2.5–3.5 mm long, penicillate. Style glabrous *Caryopsis* 3–5 mm long; embryo 30 % the length, hilum 80 % the length. (Figure 18A–C)

Other specimens examined. WESTERNAUSTRALIA: Shackleton, 30 Sep. 2002, *U. Bell* 421 (PERTH); Bruce Rock–Narrembeen Road, 12 km out of Narrembeen, 30 Sep. 2002, *U. Bell* 423 (AD n.v., PERTH); Brixton Street Wetlands, Kenwick, 16 Nov. 2011, *K.L. Brown & G. Paczkowska* KLB 897 (PERTH); between Jerramungup and Ravensthorpe at West River Crossing, 10 Nov. 1968, *E.M. Canning* WA/68 7552 (CANB); 6.1 km N along Yerina Springs road from junction of Port Gregory Road, 9 Sep. 2005, *R. Davis* 10925 (NSW n.v., PERTH); in quadrat KA9 beside State Barrier Fence NW of Karara homestead in Lochada Station, 19 Sep. 2009, *D.J. Edinger* 6940 (PERTH); NW corner of Ullaring Rock, c. 250 km W of Mulline–Davyhurst Road on ex Credo Station, 31 Aug. 2011, *N. Gibson & M.A. Langley* 4882 (CANB n.v., PERTH); Woodvale Nature Reserve, 25 km N of Perth, 21 Sep. 2007, *G.J. Keighery* 17219 (PERTH); Koodjee Nature Reserve, 5 km N of Gillingarra, 18 Oct. 2011, *G.J. & B.J. Keighery* 1763 (PERTH); Site No. 154, M & J Mailey property, W end of Noble Road, S of Gunyidi–Wubin

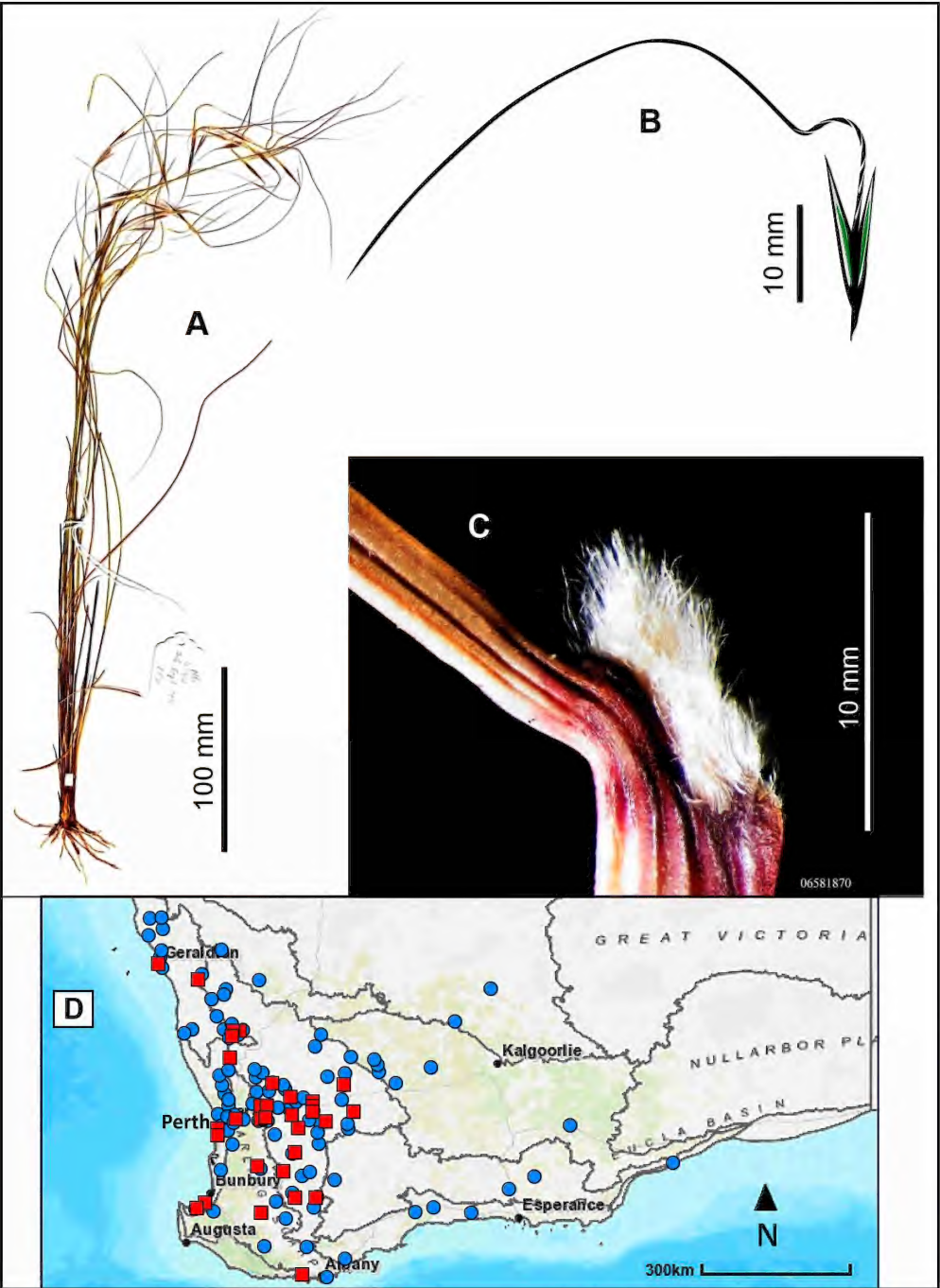


Figure 18. *Austrostipa tenuifolia*. A – image of a small whole mature plant on an herbarium sheet; B – schematic vector drawing of a single mature spikelet showing the awn column with its distinctively exaggerated apical curve just below the falcate bristle; C – lateral view of the collar region showing the distinctively dense and brightly pubescent abaxial surface of the ligule and absent auricle; D – distribution of *A. tenuifolia* (●), compared with *A. anaiwaniorum* (■). Illustrations by the author from *N. Gibson* 4004 (A), *Drummond* 4:391 (B), and *M. Hislop & M. Griffiths* WW 105.54 (C).

Road, NE of Watheroo, 22 Sep. 2005, *M. Hislop & M. Davis* WW 154-5 (PERTH); A. & C. Robinson property, W side of Robinson Road, E of Piawaning, 29 Sep. 2003, *M. Hislop & M. Griffiths* WW 105-54; Beverley Common Reserve, c. 4 km S of Beverley on W side of Great Southern Highway, 2 Oct. 2003, *M. Hislop & M. Griffiths* WW 111-33 (PERTH); Site 151, G. & V. Huckstep property, N side of Kuhl Road, S of Emu Proof Fence Road, N of Beacon, 21 Sep. 2005, *M. Hislop, R. Ovens & M. Griffiths* WW 151-18 (MEL, PERTH); near Highbury Hotel, 22 Oct. 1962, *D.N. Kraehenbuehl* 822 (AD, NSW); approx. 5 km SW of Beverley on Cropping Committee Hill, 13 Sep. 2003, *M. Ochtman* 711 (DNA *n.v.*, PERTH); Southern Bullfinch Greenstone Belt survey site BLFN07, c. 3.63 km SW of Mount Woodward, 4 Sep. 2009, *W.A. Thompson & J. Allen* 1693 (PERTH). SOUTH AUSTRALIA: Flora and Fauna Reserve, c. 85 km N of Port Lincoln, 11 Nov. 1960, *R.L. Specht* 2563 (AD).

Phenology. Flowers in winter and spring with fruit maturing in early summer; also responds to summer rain.

Distribution and habitat. Occurs in the Avon Wheatbelt, Coolgardie, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Murchison, Swan Coastal Plain, Warren and Yalgoo bioregions of south-western Western Australia (Figure 18D), southern South Australia, and inland Victoria. Occurs widely in the landscape.

Conservation status. Widespread across southern inland parts of the continent.

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References

Alvarez, I. & Wendel, J.F. (2003). Ribosomal ITS sequences and plant phylogenetic inference. *Molecular Phylogenetics and*

Evolution 29: 417–434.

- AVH (2012, 2016). The Australasian Virtual Herbarium, Council of Heads of Australasian Herbaria, <<https://avh.chah.org.au>> [accessed 12 December 2012, 16 February 2016].
- Barrosy, J., Serk, H., Granlund, I. & Pesquet, E. (2015). The cell biology of lignification in higher plants. *Annals of Botany* 115: 1053–1074.
- Bodorkos, S. & Sandiford, M. (2006). Thermal and mechanical controls on the evolution of Archean crustal deformation: examples from Western Australia. In: Benn, K., Mareschal, J.-C. & Condie, K.C. (eds) *Archean Geodynamics and Environments. Geophysical Monograph Series* 164: 131–147.
- Box, G.E.P. & Cox, D.R. (1964). An analysis of transformations. *Journal of the Royal Statistical Society, Series B* 26 (2): 211–252.
- Briske, D.D. (1991) Developmental morphology and physiology of Grasses. In: Heitschmidt, R.K. & Stuth, J.W. (eds) *Grazing Management: An Ecological Perspective*. pp. 85–108. (Timber Press: Oregon.)
- Bustam, B.M. (2010). Systematic studies of Australian stipoid grasses (*Austrostipa*) based on micro-morphological and molecular characteristics. *Biodiversitas* 11(1): 9–14.
- Byrne, M. (2008). Evidence for multiple refugia at different time scales during Pleistocene climatic oscillations in southern Australia inferred from phylogeography. *Quaternary Science Reviews* 27: 2576–2585.
- Cavanagh, A.M., Godfree, R.C. & Morgan, J.W. (2019). An awn typology for Australian native grasses (Poaceae). *Australian Journal of Botany* 67: 309–334. <https://doi.org/10.1071/BT18216>.
- Clifford, H.T. (1987). Spikelet and floral morphology. In: Soderstrom, T.R., Hilu, K.W., Campbell, C.S. & Barkworth, M.E. (eds) *Grass Systematics and Evolution*. pp. 21–30. (Smithsonian Institution Press: Washington.)
- Craig, G.F., Hickman, E.J., McQuoid, N., Newell, J., Rick, A.M. & Sandiford, E.M. (2008). *Vegetation of the Ravensthorpe Range, Western Australia: Mt Short to Kundip 1:10,000 scale*. Department of Environment and Conservation and South Coast Natural Resource Management Inc: Albany, Western Australia.)
- DSEWPC (2013). *Australia's Bioregions. Department of Sustainability, Environment, Water, Population and Communities, IBRA 7.1* <http://www.environment.gov.au/parks/nrs/science/bioregion-framework/ibra/index.html#ibra> [accessed 10 May 2013].
- Everett, J. & Jacobs, S.W.L. (1983). Studies in Australian *Stipa* (Poaceae). *Telopea* 2(4): 391–400.
- Everett, J., Jacobs, S.W.L. & Nairn, L. (2009). *Austrostipa*. In: *Flora of Australia*, Vol. 44A, Poaceae 2, pp.15–62. (ABRS/CSIRO Publishing: Melbourne.)
- Freitag, H. (1985). The genus *Stipa* (Gramineae) in southwest and south Asia. *Notes from the Royal Botanic Garden Edinburgh* 42(3): 355–489.
- Gonzalez, R., Aedo, C., Nickrent, D.L. & Garcia, M.A. (2012). A numerical taxonomic investigation of *Stipa* sect. *Smirnovia* and *S.* sect. *Subsmirnovia* (Poaceae). *Systematic Botany* 37(3): 665–670.
- Groves, R.H. & Whalley, R.D.B. (2002). Grass and grassland ecology in Australia. *Flora of Australia* 43: 157–182.
- Hammer, Ø., Harper, D.A.T. & Ryan, P.D. (2001). PAST: Paleontological Statistics Software Package for Education and Data Analysis. *Palaeontologia Electronica* 4(1): 9 pp. http://palaeo-electronica.org/2001_1/past/issue1_01.htm
- Hooker, C. (2002). Vickery, Joyce Winifred (1908–1979). <https://adb.anu.edu.au/biography/vickery-joyce-winifred-11926>
- Hughes, D.K. (1921). A revision of the Australian species of *Stipa*. *Bulletin of Miscellaneous Information* 1: 1–30.
- Jacobs, S.W.L. & Everett, J. (1996). *Austrostipa*, a new genus, and new names for Australasian species formerly included in *Stipa* (Gramineae). *Telopea* 6(4): 579–595.
- Jacobs, S.W.L., Everett, J. & Barkworth, M.E. (1996). Clarification of morphological terms used in the *Stipeae* (Gramineae), and a reassessment of *Nassella* in Australia. *Taxon* 44(1): 33–41.
- Jacobs, S.W.L., Everett, J., Barkworth, M.E., & Hsiao, C. (2000). Relationships within the Stipoid grasses (Gramineae). In: Jacobs, S.W.L. & Everett, J. (eds) *Grasses: Systematics and Evolution*. pp. 75–82. (CSIRO: Melbourne.)
- Jacobs, S.W.L., Bayer, R., Everett, J., Arriaga, M., Barkworth, M., Sabin-Badereau, A., Torres, A., Vazquez, F. & Bagnall, N. (2007). Systematics of the Tribe *Stipeae* (Gramineae) using molecular data. *Aliso* 23: 349–361.
- Jessop, J., Dashorst, R.M. & James, F.M. (2006). *Grasses of South Australia: An Illustrated Guide to the Native and Naturalised Species*. (Wakefield Press: Kent Town, South Australia.)
- Kern, S., Jasper, R., True, D., & Gibson, N. (2008). *Floristic survey of the Ravensthorpe Range*. (Western Botanical: Bassendean, W.A.).
- Krawczyk, K., Nobis, M., Nowak, A., Szczecińska, M. & Sawicki, J. (2017). Phylogenetic implications of nuclear rRNA IGS variation in *Stipa* L. (Poaceae). *Nature Scientific Reports* 7: 11506 | DOI:10.1038/s41598-017-11804-x
- Markey, A., Kern, S. & Gibson, N. (2012). Floristic Communities of the Ravensthorpe Range. *Conservation Science Western Australia* 8: 187–239.
- Nair, S.K. *et al.* (2010). Cleistogamous flowering in barley arises from the suppression of microRNA-guided HvAP2 mRNA

- cleavage. *Proceedings of the National Academy of Sciences* 107(1): 490–495.
- Plants of the World Online, Kew Science, <http://www.plantsoftheworldonline.org/taxon/urn:lsid:ipni.org:names:60437381-2> [accessed 19 May 2021].
- Romaschenko, K., Peterson, P.M., Soreng, R.J., Garcia-Jacas, N. & Susanna, A. (2010). Phylogenetics of *Stipeae* (Poaceae: Pooideae) based on plastid and nuclear DNA sequences. In: Seberg, O., Petersen, G., Barfod, A.S. & Davis, J.I. (eds) *Diversity, Phylogeny, and Evolution in the Monocotyledons*. pp. 511–537. (Aarhus University Press: Denmark.)
- Smith, M.G. & Jones, A. (2018). *Threatened and Priority Flora List, 16 January 2018*. Department of Biodiversity, Conservation and Attractions: Kensington, Western Australia.
- Syme, A.E., Murphy, D.J., Homes, G.D., Gardner, S., Fowler, R. & Cantrill, D.J. (2012). An expanded phylogenetic analysis of *Austrostipa* (Poaceae:Stipeae) to test infrageneric relationships. *Australian Systematic Botany* 25: 1–10.
- Syme, A.E. (2012). Diversification rates in the Australasian endemic grass *Austrostipa*: 15 million years of constant evolution. *Plant Systematics & Evolution* 298: 221–227.
- Thiers, B. (2014). *Index Herbariorum: A global directory of public herbaria and associated staff*. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/>
- Tkach N., Nobis, M., Schneider, J., Becher, H., Winterfeld, G., Jacobs, S.W.L. & Röser, M. (2021). Molecular phylogenetics and micromorphology of Australasian *Stipeae* (Poaceae, Subfamily Pooideae), and the interrelation of whole-genome Duplication and evolutionary radiations in this grass tribe. *Frontiers in Plant Science* 11: 630788. doi: 10.3389/fpls.2020.630788.
- Thompson, W.A. & Allen, J. (2013). Flora and vegetation of greenstone formations of the Yilgarn Craton: the northern Forrestania Greenstone Belt (Mount Holland area). *Conservation Science Western Australia* 8(3): 295–312.
- Vickery, J.W. (1980). Four new species of *Stipa* (Poaceae). *Telopea* 2(1): 11–15.
- Vickery, J.W., Jacobs, S.W.L. & Everett, J. (1986). Taxonomic studies in *Stipa* (Poaceae) in Australia. *Telopea* 3(1): 1–23.
- Western Australian Herbarium (1998–). *Florabase—the Western Australian Flora*. Department of Biodiversity, Conservation and Attractions. <https://florabase.dpaw.wa.gov.au/> [Accessed 12 July 2021].
- Williams, A.R. (2011). *Austrostipa* (Poaceae) subgenus *Lobatae* in Western Australia. *Telopea* 13(1–2): 177–192.
- Winterfeld, G., Schneider, J., Becher, H., Dickie, J. & Röser, M. (2015). Karyosystematics of the Australasian stipoid grass *Austrostipa* and related genera: chromosome sizes, ploidy, chromosome base numbers and phylogeny. *Australian Systematic Botany* 28(2–3): 145–159. <https://doi.org/10.1071/SB14029>.

***Exocarpos capnodioides* (Santalaceae), a new species from
southern Australia allied to *E. aphyllus***

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SHORT COMMUNICATION

The genus *Exocarpos* Labill. comprises approximately 27 species, 12 of which occur in Australia and its offshore island territories. *Exocarpos aphyllus* R.Br. is a widespread species occurring throughout arid and semi-arid mainland Australia. During fieldwork in south-western Western Australia in the 1990s, apparent differences in the habit and branching pattern in plants of *E. aphyllus* occurring in the southern wheatbelt were noted by the author, suggesting these plants may represent an undescribed taxon. Subsequent preparation of a treatment of the Santalaceae for the fifth edition of the *Flora of South Australia* (Lepschi & Barlow 2012) confirmed the existence of a second taxon, along with its occurrence in South Australia. This species is formally described here as *Exocarpos capnodioides*, and a revised description of its closest relative, *E. aphyllus* is provided for comparison.

Exocarpos capnodioides* Lepschi, *sp. nov.

Type: unmanaged Reserve 31111, north-east of Lake Grace, off south boundary track, east of Burngup Rd North, Western Australia, 1 October 2020, *M. Hislop* 4834 (*holo*: CANB 838235!; *iso*: AD, K, L, MEL, NY, PERTH 09251766, all *n.v.*).

Exocarpos sp. Ardath (J. Buegge D 62), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 14 April 2022].

Erect, *shrub* or small *tree* (0.4–)1–2(–3) m tall, light green to green, yellowish green or yellowish, very rarely glaucous, rapidly glabrescent (mature branchlets glabrous); young growth densely puberulous with simple to dendritic hairs <0.05–0.2 mm long, the hairs reddish to reddish brown or blackish brown, the indumentum sometimes matted (with individual hairs difficult to discern), some scattered, colourless, translucent hairs sometimes also present. Fertile *branchlets* subterete to terete, diverging at 10°–40°(–70°) from the main branchlet, 1.2–3.3 mm diam., longitudinally ridged, the ridges minutely verruculose to smooth, 0.3–0.6 mm wide, furrows between the ridges <0.05 mm wide, minutely papillate to almost smooth. *Leaves* persistent (retained on the branchlets and gradually weathering away), scale-like, sessile, glabrescent, yellowish brown when young, ageing greyish, appressed to rarely ascending (spreading-ascending to spreading when subtending an inflorescence), straight to slightly incurved, very broadly triangular to rounded-triangular or broadly ovate, 0.4–0.9 mm long, 0.6–1.3 mm wide,

apex obtuse to rounded; young leaves sparsely to moderately puberulous with simple to dendritic, crisped to flexuose hairs, $<0.05\text{--}0.2$ mm long, the hairs reddish to reddish brown, some colourless, translucent hairs sometimes also present. *Inflorescence* a simple (very rarely compound), condensed spike of 5–8 (very rarely –14) flowers; rhachis 1.3–2.5 mm long, hairy, densely puberulous with simple to dendritic, straight to flexuose hairs $<0.05\text{--}0.2$ mm long, the hairs reddish to reddish brown or blackish brown, the indumentum often matted and becoming scurfy (with individual hairs difficult to discern) and greyish with age. *Bracts* scale-like, sessile, cupped, hairy, sometimes glabrescent, densely puberulous with simple to dendritic, straight to flexuose hairs $<0.05\text{--}0.2$ mm long, the hairs reddish to reddish brown or blackish brown, the indumentum often matted and becoming scurfy (with individual hairs difficult to discern); broadly to depressed ovate, 0.4–0.5 mm long, 0.6–0.7 mm wide, apex rounded. *Flowers* obscurely pedicellate, floral tube and pedicel c. 0.2 mm long. *Tepals* glabrous to minutely papillate, more or less ovate, 0.8–1.1 mm long, 0.5–0.7 mm wide, pale yellow to orangey yellow in life (rarely recorded as green or yellow-green), drying yellowish brown; apex incurved, thickened. *Anthers* broadly to very broadly elliptic, 0.2 mm long; filaments 0.15–0.2 mm long. *Disc* shallowly lobed, 0.6–0.7 mm diam. *Style* 0.2 mm long; stigma obscurely trilobed. *Fruit* a drupe, poorly known, fruit (possibly immature) ellipsoid to subglobose, 2.5–3 mm long, smooth to indistinctly longitudinally ribbed (due to ornamentation on endocarp) when dry, drying greenish brown, glabrescent, puberulous with simple to dendritic, straight to flexuose hairs $<0.05\text{--}0.2$ mm long, the hairs reddish to reddish brown or blackish brown, some colourless, translucent hairs also sometimes present, the indumentum often matted and becoming scurfy (with individual hairs difficult to discern). Fruiting receptacle poorly known (possibly immature), \pm transversely elliptic, orange-red to (possibly) red, hairy with simple to dendritic, crisped to flexuose hairs <0.05 mm long, the hairs reddish to reddish brown or blackish brown, c. 2 mm long, edibility unknown. (Figure 1)

Diagnostic characters. *Exocarpos capnodioides* may be recognised by the distinctive, reddish, reddish brown or blackish brown indumentum, most readily observed on the floral rhachis, but also present on young vegetative growth as well as the bracts, fruits and the fruiting receptacle. Some colourless, translucent hairs may be present on some plants, but these are infrequent and are scattered amongst the otherwise distinctively coloured hairs of this species. Plant height, branching pattern and tepal colour are additional characters which aid in separation of *E. capnodioides* from its closest relative *E. aphyllus* (see ‘Affinities’ below).

Other specimens examined. WESTERN AUSTRALIA: adjacent railway line, southern end of Water Reserve, Ardath, July 1998, *J. Buegge* D 62 (BRK *n.v.*, PERTH); 25.5 km due NNE of Mt Ney, 8 Aug. 1983, *M.A. Burgman* & *S. McNee* MAB1841 (PERTH); 18 km W of Beete, 20 Aug. 1995, *R.J. Cranfield* 10244 (PERTH); 6.8 km E of Twilight Cove, 6 Apr. 2000, *R. Davis* 9218 (PERTH); Flints Farm, house yard, 50 km NE of Hyden, 8 Aug. 2000, *J.M. Flint* 172 (PERTH); property of R. & J. Newman, E side of Magenta Road, between Grant & Ardler Road, SE of Newdegate, 27 Sep. 2007, *M. Hislop* & *H. Mills* WW 215 – 23 (NRB *n.v.*, PERTH); property of W. Newman, S of Tack Road between Old Ravenshorpe Road and Traco Road, SE of Newdegate, 24 Sep. 2008, *M. Hislop* & *H. Mills* WW 230 – 6 (PERTH); unmanaged Reserve 31111, NE of Lake Grace, off S boundary track, E of Burngup Rd North, 1 Oct. 2020, *M. Hislop* 4835 (CANB, PERTH); Kumarl, Aug. 1938, *L. Horbury s.n.* (PERTH 02363658); 8.9 km SW of Duck Road on Holland Track Road, c. 20 km W of Holt Rock, 11 Aug. 1996, *B.J. Lepschi* 2847 & *T.R. Lally* (PERTH); 11 miles [c. 17.7 km] E of Corrigin on the road to Bendering, 13 July 1970, *B.R. Maslin* 509 (PERTH); 5 km N of Lake Cronin, 23 Aug. 1979, *K.R. Newbey* 5818 (PERTH); 8 km N of Point Dover, 4 Sep. 1968, *P.G. Wilson* 7702 (PERTH). SOUTH AUSTRALIA: Hundred of Ramsay. Section 141, 8 Sep. 1963, *B.J. Blaylock* 1023 (AD); between Bute and Kadina, 4 July 1968, *B. Copley* 1928 (AD, OSH *n.v.*); near Mt Bosanquet, 16 Sep. 1972, *F.A. Mason* (AD); Flora and Fauna reserve, Hundred of Hambidge, north-east of Lock, 8

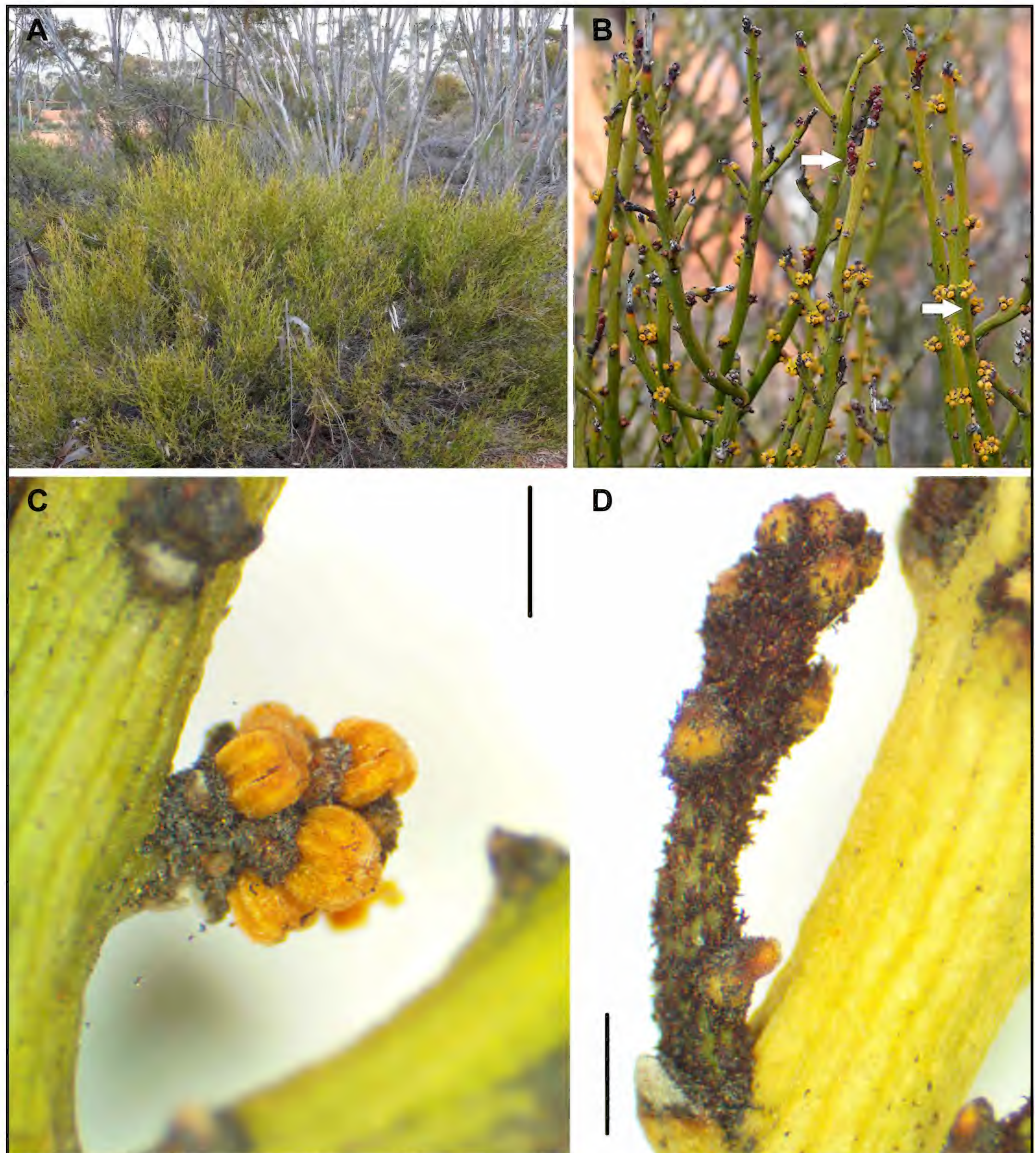


Figure 1. *Exocarpos capnodioides*. A – habit; B – flowering plant with young growth, showing yellow to orangey yellow tepals (arrows indicate dark coloured indumentum visible on inflorescence rhachises and young shoots); C – inflorescence showing matted, scurfy, dark coloured indumentum on the floral rhachis. D – young shoot showing dark coloured indumentum. Scale bar = 1 mm (C, D). Images taken by M. Hislop (A, B) and A.N. Schmidt-Lebuhn (C, D). Associated voucher specimens: *M. Hislop* 4834 (holotype collection) (A, B) and *M. Hislop* 4835 (C, D).

Nov. 1960, *R.L. Specht* 2392 (AD); 1.5 miles [c. 2.4 km] N of Winulta P.O., 14 Sep. 1961, *D.E. Symon* s.n. (AD 98662822); 4.83 km N of Long Plains, 6 July 1971, *D.J.E. Whibley* 3387 (AD, M *n.v.*, MO *n.v.*, ODU *n.v.*, PRE *n.v.*).

Phenology. Flower buds recorded December, February, March and July; flowers recorded between July and November. Developing fruits recorded during April; fruits recorded between July and October.

Distribution and habitat. Occupies a disjunct range in Western Australia and South Australia (Figure 2). In Western Australia, *E. capnodioides* occurs in the south-west of the state, in an area bounded approximately by Koolyanobbing, Corrigin, Lake Cronin and Mt Ragged. Collections from Point Dover (south of Caiguna) and Twilight Cove (south of Cocklebidy), appear as disjunct from the otherwise easternmost occurrences of the species in Western Australia, near Mt Ragged. However, this could be an artefact of inadequate collecting between Cape Arid and these localities, reflecting the limited and difficult access to this part of the southern coastline of the state. In South Australia, it occurs on the Eyre and Yorke Peninsulas, south of approximately 33°S, eastwards to Long Plains (north-north-west of Mallala). Recorded from a variety of substrates, e.g. sand, sandy clay or sand over clay, sandy loam, loam, clay loam and clay, but mostly from heavier soils (i.e. loam or clay), sometimes along ephemeral creek lines or other low-lying sites. Also recorded from dunes adjacent to playa lakes and in a saltpan area in Western Australia. Some South Australian populations are recorded as occurring near rock outcrops. Parent materials recorded include granite, ironstone, laterite, limestone and gypsiferous substrate. Occurs in eucalypt woodland and mallee communities with a shrubby understorey.

The distribution of *E. capnodioides* overlaps that of *E. aphyllus* in the southern part of the range of the latter species, and both species have been collected from the same reserves in Western Australia and South Australia. However, no instances of direct sympatry or mixed populations have been documented, and it is not known whether there is any ecological separation between the taxa.

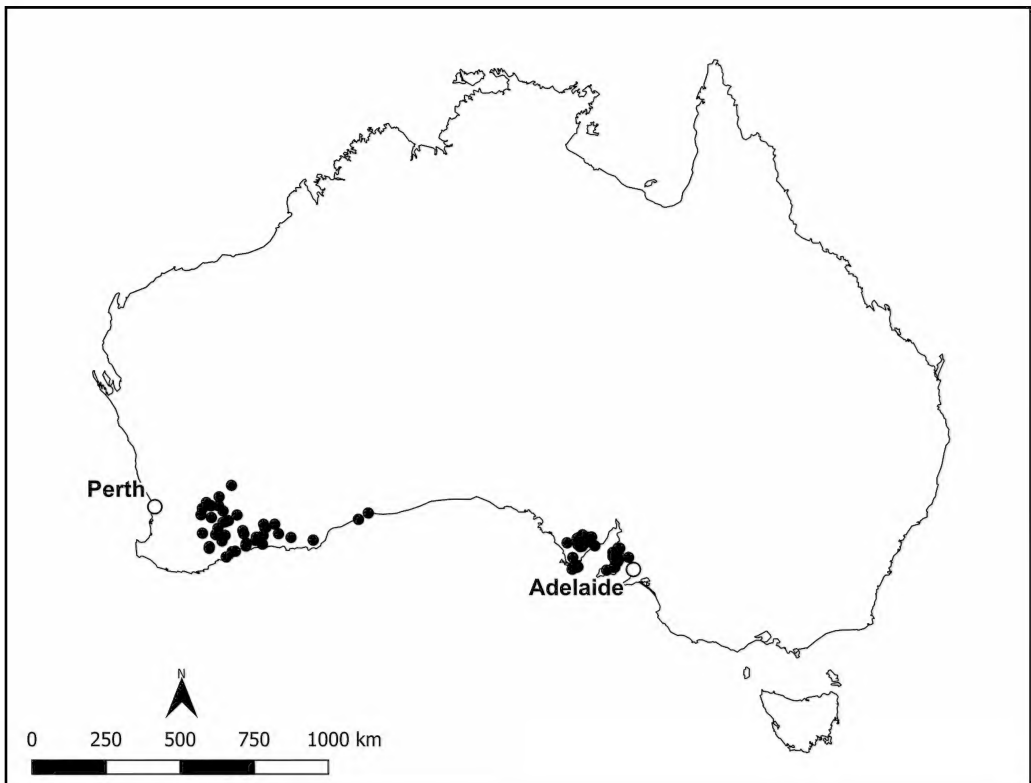


Figure 2. Distribution of *Exocarpos capnodioides* in Australia.

Conservation status. Not considered at risk. Represented in conservation reserves in both Western Australia and South Australia.

Etymology. The epithet refers to the resemblance of the distinctive, dark indumentum of this species (especially on the floral rachis) to the hyphae of ascomycete fungi in the family Capnodiaceae commonly known as sooty moulds (Chomnunti *et al.* 2014). The indumentum of *E. capnodioides* has previously been misinterpreted as a fungal infection (see below under ‘Notes’).

Affinities. *Exocarpos capnodioides* is most closely related to *E. aphyllus*. Both species share a similar overall morphology, apparent ecological requirements and phenology. *Exocarpos capnodioides* may be separated from *E. aphyllus* most readily by indumentum. Hairs in *E. capnodioides* are characteristically reddish to reddish brown or blackish brown (although some scattered, colourless, translucent hairs may also occur on some plants), as compared to hairs in *E. aphyllus*, which are colourless and translucent. Plant habit, height and branching pattern also differ between the two species, although there is considerable overlap in these characters and the latter is difficult to quantify, at least on herbarium material. Differences in habit and branching pattern are best observed in living plants. *Exocarpos capnodioides* is a shrub, (0.4–)1–2(–3) m tall, while *E. aphyllus* may be a shrub or small tree, 1–3(–6) m tall. The branching pattern in *E. capnodioides* also tends to be \pm erect, with fertile branchlets diverging from the stem at 10°–40°(–70°) from the main branchlet, while in *E. aphyllus* branching tends to be less erect and more divaricate, with fertile branchlets diverging at (10°–)20°–70° from the main branchlets. Differences are also evident in tepal colour, with tepals in *E. capnodioides* pale yellow to orangey yellow in life (rarely recorded as green or yellow-green), drying yellowish brown, while tepals in *E. aphyllus* are green, yellow-green or greenish yellow in life (rarely recorded as pale yellow or yellow), drying greenish to yellowish brown.

Notes. The fruit and fruiting receptacle of *E. capnodioides* is poorly known. Several fruiting collections of this species have been seen, but it is unclear whether these represent mature material (cf. description above), and limited information is available as to the form and colour of the fruit and receptacle in life. Possibly immature receptacles on *M. Hislop* 4834 are dull orange-red, and collectors notes on *P.G. Wilson* 5677 (PERTH) records ‘fruit red’, and this may also refer to the colour of the fruiting receptacle. Morphology of mature fruits and the fruiting receptacle in *E. capnodioides* could be expected to be similar to that of *E. aphyllus* (see description below). Flower (tepal) colour in two specimens of *E. capnodioides* (*Hickman & Gilfillan* 1361 and 1481, both PERTH) is recorded as ‘white’, but this is likely to be in error and could be the result of confusion with other superficially similar, ‘leafless’, shrubby Santalaceae occurring in the same area (e.g. *Choretrum glomeratum* or *Leptomeria* spp.). Tepals in white-flowered species of Australian Santalaceae dry whitish, rather than yellowish brown (Lepschi, pers. obs.), as is the case in *Hickman & Gilfillan* 1361 and 1481.

The distinctive habit and branching pattern of *E. capnodioides* was noted by J.G.O. Tepper on two collections of this species from near Ardrossan on South Australia’s Yorke Peninsula made in 1879 (*Tepper* 337 (AD 95715016 and MEL 1639 p.p.) and *Tepper* 527 (MEL 1639 p.p.)). Tepper notes ‘This *Exocarpos* seems quite distinct in habit from *E. aphylla* [*sic*] ...’ and refers to the generally lower stature ‘3–5 ft and 4–6 ft’ of *E. capnodioides* vs ‘5–8 ft’ for *E. aphyllus* and the more erect and less divaricate branching pattern of *E. capnodioides* (‘branches very thickly set, upright’ and ‘branches ... thickly packed ... stiff and upright’) as compared with *E. aphyllus*. Swiss botanist and Santalaceae specialist Hans Ulrich Stauffer (1929–1965) appears to have misinterpreted the indumentum of *E. capnodioides* as a fungal infection. Nearly all material of *E. capnodioides* examined by Stauffer (and determined by him as *E. aphyllus*), is annotated with the comment ‘infected by a capnodiaceous fungus!’ No evidence of such fungal infections has been seen by the present author on either *E. capnodioides* or *E. aphyllus*, although both species occasionally exhibit scattered blackish specks, mainly on older vegetative growth

(branchlets). The nature and origin of this speckling is unknown, but it appears infrequently as widely scattered, small, dark spots on the epidermis, and does not resemble the distinctive indumentum of *E. capnodioides*.

Exocarpos aphyllus R.Br., *Prodr. Fl. Nov. Holland.* 357 (1810) (as ‘aphylla’). *Type citation*: ‘(J.M.D.) v.v.’ *Type specimen*: Anch[orage]: VIII [Thistle Is.] South Coast [South Australia], *s. dat.*, R. Brown *s.n.* [Iter Austral. 3203] (*lecto*, designated by Stauffer, *Mitt. Bot. Mus. Univ. Zürich* ccxiii. (Rev. Anthobol.) 169 (1959): BM 001015639 image!; *isolecto* or *syn*: BM 001015640 image!, E 00346093 image!, K 000880816 image!, K 000880817 image!, NSW120386 *n.v.*). *Xylophyllos aphyllus* (R.Br.) Kuntze, *Revis. Gen. Pl.* 2: 589 (1891).

Exocarpos leptomerioides F.Muell. ex Miq., *Ned. Kruidk. Arch.* iv. 103 (1859) (as ‘Exocarpus’). *Type citation*: ‘Ad. fl. Murray (STUART), ...’. *Type specimen*: [illegible] fl. Murray versus M. Brown [Mount Adw.], [South Australia], *s. dat.*, *leg. ign. s.n.* (*lecto*, designated by Stauffer, *Mitt. Bot. Mus. Univ. Zürich* ccxiii. (Rev. Anthobol.) 169 (1959): U 0006458 image!; *isolecto*: HBG 510385 image!, MEL 1672!).

Erect, *shrub* or small *tree* 1–3(–6) m tall, light to dark green or grey-green, rarely yellowish green or yellowish or glaucous, rapidly glabrescent (mature branchlets glabrous); young growth sparsely to moderately puberulous with minute papillae or simple to dendritic hairs <0.05–0.1 mm long, the hairs colourless. Fertile *branchlets* subterete to terete, diverging at (10°–)20°–70° from the main branchlets, 0.9–3 mm diam., longitudinally ridged, the ridges minutely papillate to smooth, 0.2–0.6 mm wide, furrows between the ridges <0.05–0.1 mm wide, minutely papillate to almost smooth. *Leaves* persistent (retained on the branchlets and gradually weathering away), scale-like, sessile, glabrescent, but hairs frequently persisting along margins and on adaxial surface, greenish brown to yellowish brown when young, ageing greyish, appressed to rarely ascending (spreading-ascending to spreading when subtending an inflorescence), straight to slightly incurved, triangular to broadly rounded-triangular or rarely ovate, 0.3–0.7 mm long, 0.4–1 mm wide, apex acute to obtuse; young leaves sparsely to moderately puberulous with apparently simple, crisped to flexuose hairs, <0.05–0.1 mm long, the hairs colourless. *Inflorescence* a condensed, simple (or rarely compound) spike of 6–14(–25) flowers; rhachis (1.3–)2–5(–6.5) mm long, hairy, densely puberulous with apparently simple, straight hairs <0.05 mm long, the hairs colourless. *Bracts* scale-like, sessile, cupped, hairy, densely puberulous with apparently simple, straight hairs <0.05–0.1 mm long, the hairs colourless; broadly to depressed ovate, 0.4–0.5 mm long, 0.6–1 mm wide, apex rounded. *Flowers* obscurely pedicellate, floral tube and pedicel 0.2 mm long. *Tepals* glabrous to minutely papillate, rounded-triangular to ovate, 0.6–1.0 mm long, 0.6–0.8 mm wide, green, yellow-green or greenish yellow in life (rarely recorded as pale yellow or yellow), drying greenish to yellowish brown; apex incurved, thickened. *Anthers* broadly to very broadly elliptic, 0.2 mm long; filaments 0.15–0.2 mm long. *Disc* shallowly lobed, 0.6–0.8 mm diam. *Style* 0.2 mm long; stigma obscurely trilobed. *Fruit* a drupe, mature fruit ellipsoid to subglobose, drying greenish brown, smooth to indistinctly longitudinally ribbed (due to ornamentation on endocarp) when dry, glabrescent, puberulous with simple to dendritic, crisped to flexuose hairs <0.05 mm long, the hairs colourless, 3–5 mm long. Fruiting receptacle depressed obovoid to transversely elliptic, orange-red to dark red when mature, hairy with simple to dendritic, crisped to flexuose hairs <0.05 mm long, the hairs colourless, *c.* 2 mm long, the receptacle edible. (Figure 3)

Other specimens examined. WESTERN AUSTRALIA: 10 km W of homestead in Giralia Station, S of Exmouth Gulf, 28 June 2006, D.J. Edinger 5996 C (PERTH); W edge of Mortlock Creek, Wongan Hills, 17 July 1976, K.F. Kenneally 5364 (PERTH); Nungarin Reserve, 1978, G. Perry 804 (PERTH). SOUTH AUSTRALIA: 12 km SE of homestead, Kokatha Station, 8 Sep. 1995, F.J. Badman 8573

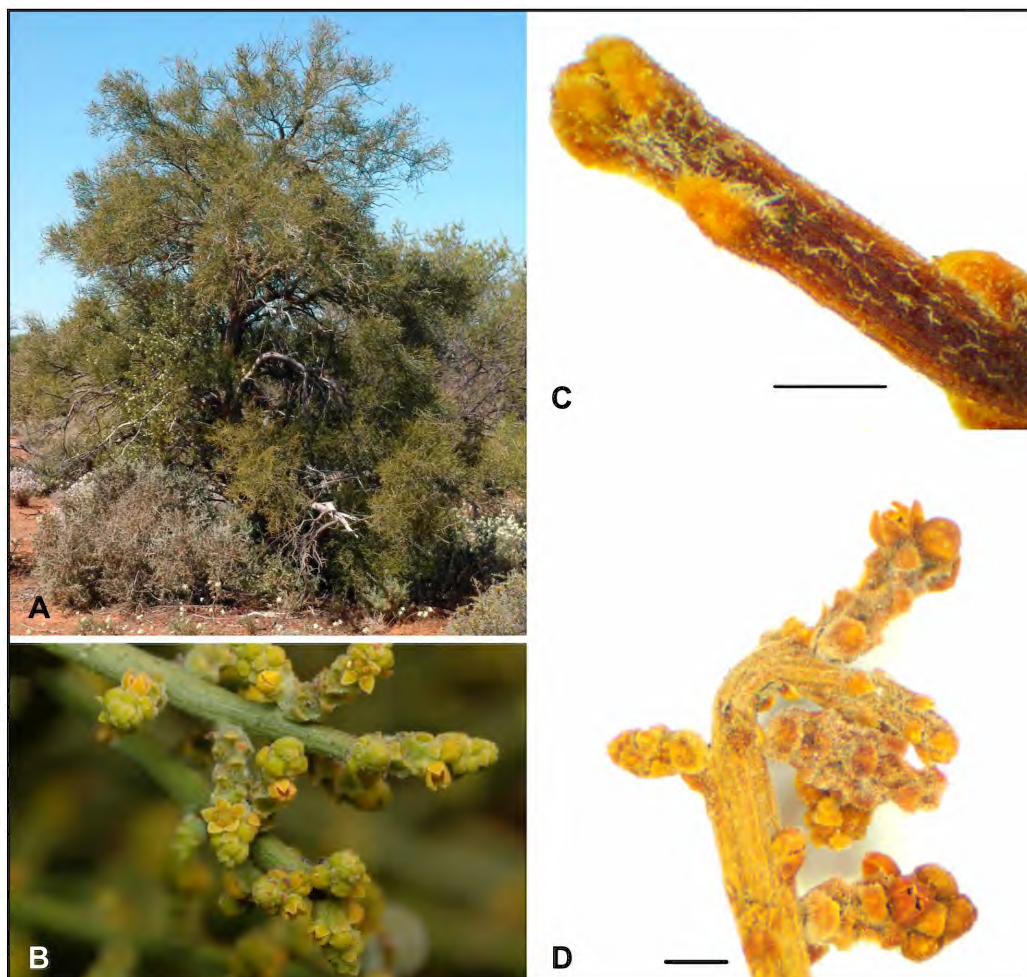


Figure 3. *Exocarpos aphyllus*. A – habit; B – flowering plant showing greenish yellow to yellow tepals. Colourless indumentum visible on inflorescence rhachises. C – young shoot showing colourless indumentum. D – flowering branchlet. Colourless indumentum visible on young shoot at centre right, inflorescence rhachises and bracts. Scale bar = 1 mm (C, D). Images taken by M. Fagg (A, B) and A.N. Schmidt-Lebuhn (C, D). Associated location and voucher specimens: photographed c. 35 km north of Yalgoo, WA, © M. Fagg 2009 (A); R.W. Purdie 7330 (B) and R.A. Saffrey 811 (C, D).

(AD); Garden Well Island [Lake Gairdner], 10 Apr. 1993, R.J. Bates 32006 (AD); Clements Gap Conservation Park, 10 Oct. 1988, H.P. Vonow 765 (AD, CANB). QUEENSLAND: 3 miles [c. 4.8 km] NE of Leyburn, 9 Jan. 1964, H.U. Stauffer & S.L. Everist 5528 (CANB, Z n.v.); c. 40 km N of Goondowindi along Leichhardt Highway, 8 Feb. 1983, I.R. Telford 9521 & G. Butler (CANB). NEW SOUTH WALES: S side of North Boundary Fire Trail, 5.8 km W of West Fire Trail, Tarawi Nature Reserve, 8 Nov. 2000, P.C. Jobson 6670, A.E. Orme & G.M. Towler (CANB, NSW n.v.); 34 miles [c. 54 km] N of Deniliquin, 21 Jan. 1966, J.H. Leigh S402 & W.E. Mulham (CANB); Mt Murchison Station, Wilcannia, 2 Aug. 1966, P.N. Martensz s.n. (CANB 315135, MU). VICTORIA: south shore of Rocket Lake, 60 km SW of Mildura, 9 Oct. 1977, B. Barnsley 73, M.D. Crisp & D.J. Cummings (AD, CANB, MEL); 1 km E of Nyah West on Nyah West to Murray Valley Highway road, 7 Sep. 1991, B. Hadlow 641 (CANB, MEL).

Phenology. Flowers recorded all months of the year; mature fruits recorded between April and December.

Distribution and habitat. Widespread in the drier parts of mainland Australia, excluding the Northern Territory, mostly south of 25° latitude (Figure 4). *Exocarpos aphyllus* has a more or less continuous distribution from the Exmouth area in Western Australia, south and east through the wheatbelt and arid parts of the state, including the southern margin of the Nullarbor Plain, eastwards through southern South Australia (including Kangaroo Island), north-western Victoria, west of the Great Dividing Range in New South Wales, and north to the Darling Downs district of Queensland. Recorded from a wide variety of substrates, e.g. bird guano, sand (including dunes), sandy clay or sand over clay, sandy loam, loam, clay loam and clay, ranging from skeletal soils in rocky sites or over rock pavement, to deeper substrates, sometimes along ephemeral creek lines and other low-lying sites or semi-saline areas associated with salt lakes. Parent materials recorded include basalt, granite, gypsum, laterite, limestone, quartzite, sandstone and shale. Recorded from woodland communities (often with a shrubby understorey) with a variety of tree species (predominantly *Acacia*, *Callitris*, *Casuarina* and *Eucalyptus*), as well as mallee woodlands, *Acacia*, *Melaleuca* and other shrubland or ‘scrub’ communities. See under *E. capnodioides* for discussion on sympatry.

Conservation status. Not considered at risk. Widespread and common in suitable habitat and represented in several conservation reserves in all mainland states.

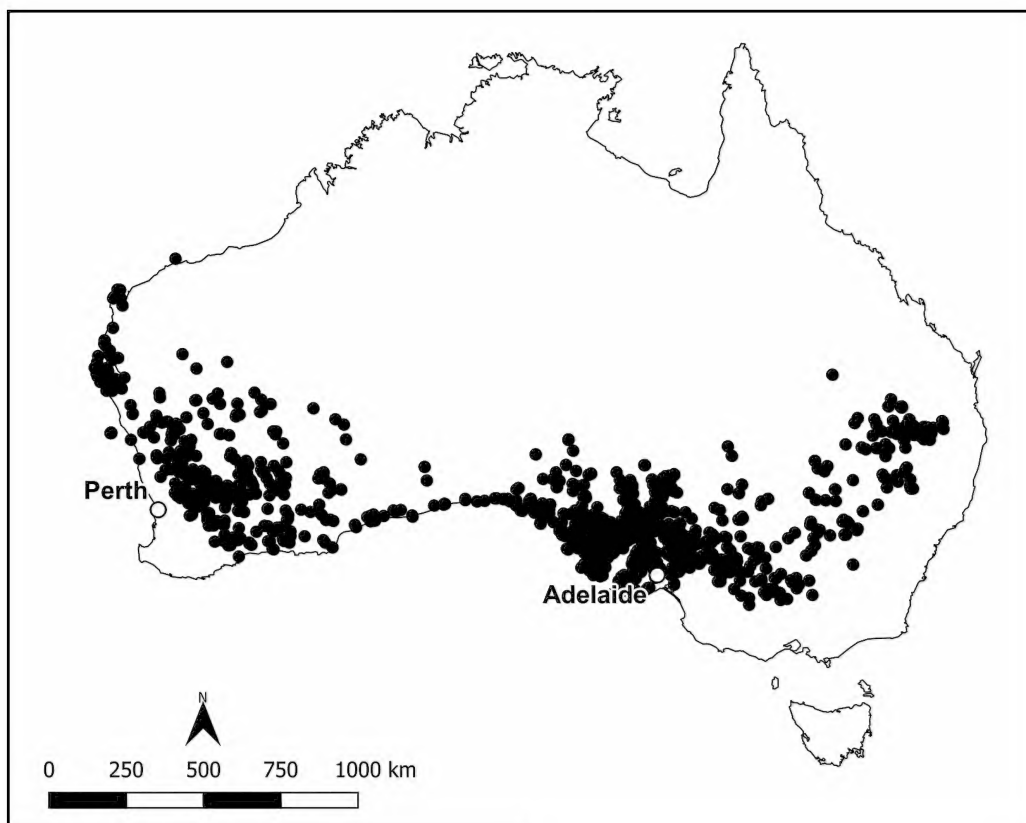


Figure 4. Distribution of *Exocarpos aphyllus* in Australia.

Acknowledgements

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References

- Chomnunti, P., Hongsanan, S., Aguirre-Hudson, B., Tian, Q., Peršoh, D., Dhami, M.K., Alias, A.S., Xu, J., Liu, X., Stadler, M. & Hyde, K.D. (2014). The sooty moulds. *Fungal Diversity* 66: 1–36.
- Lepschi, B.J. & Barlow, B.A. (2012). Santalaceae (version 1). In: Kellermann, J. (ed.), *Flora of South Australia* (ed. 5). https://cdn.environment.sa.gov.au/environment/docs/FSA_Santalaceae_01.pdf [accessed 3 May 2022].

From Engler to APGIV: a short history of the botanical arrangement of the Western Australian Herbarium collections

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SHORT COMMUNICATION

Modern herbarium collections typically have one of three different systems of arrangement: alphabetical, phylogenetic, or a combination of the two. Originally Western Australia had three recognised botanical collections housed in separate institutions. It is not documented how the early collections were initially arranged by Bernard Henry Woodward, the Director of the Museum and Art Gallery herbarium collections (1894–1916), by the Forests Department Herbarium (established in 1916), or by the Bureau of Agriculture's first botanist Alexander Morrison in 1897; however it is likely they were all arranged in alphabetical order by family. In 1913, Frederick Stoward, Botanist and Pathologist of the Department of Agriculture (renamed in 1898 from Bureau), mentioned a need for rearrangement and cataloguing of the Herbarium, which was undertaken by assistant Mr [F.W.] Wakefield (Stoward 1913). In 1920, Desmond Andrew Herbert, appointed Economic Botanist and Pathologist, was assisted by Vera McNeilance Prowse in a further re-organisation of this herbarium. Numbering about 6,000 specimens, several collections the herbarium had received were combined, including those of James Drummond, William V. Fitzgerald, George Maxwell, and Ferdinand von Mueller (Gardner 1947; Green 1990; Underwood 2011).

The first documented systematic family arrangement of botanical collections of Western Australia commenced in July 1924 with the appointment of Charles Austin Gardner as Assistant Botanist in the Department of Agriculture and was completed by June 1926 (Carne 1925; Carne 1926). Being taken with the Englerian notion of arranging families in order of increasing flower complexity within monocotyledons and dicotyledons, Gardner arranged the families and genera in the Herbarium according to Engler's system published in Engler and Prantl's (1887–1915) *Die Natürlichen Pflanzenfamilien*.

When the State Herbarium was officially established in 1929 within the Department of Agriculture headquarters on St Georges Terrace (Fitzpatrick 2011), after the amalgamation of the Department of Agriculture Herbarium and Forests Department Herbarium, this classification system was continued. The collection was soon rehoused within the State Observatory in West Perth (December 1933 to 1959) (Underwood 2011). At about this time Gardner, now Government Botanist and Curator of the State Herbarium (Green 1990), allocated a consecutive number for every plant family in the world then recognised by Engler. Where a family had not been recorded for Western Australia, it was still allocated a number, despite there being no folders or specimens in the Western Australian Herbarium at the time. Gardner annotated a copy of J.C. Willis' (1919) 4th edition of *A Dictionary of the Flowering*

Plants and Ferns, a portable version of the Engler system, with his numbering system (Figure 1), presumably on the basis that *Die Natürlichen Pflanzenfamilien*, consisting of multiple, large volumes, was likely too unwieldy to manage.

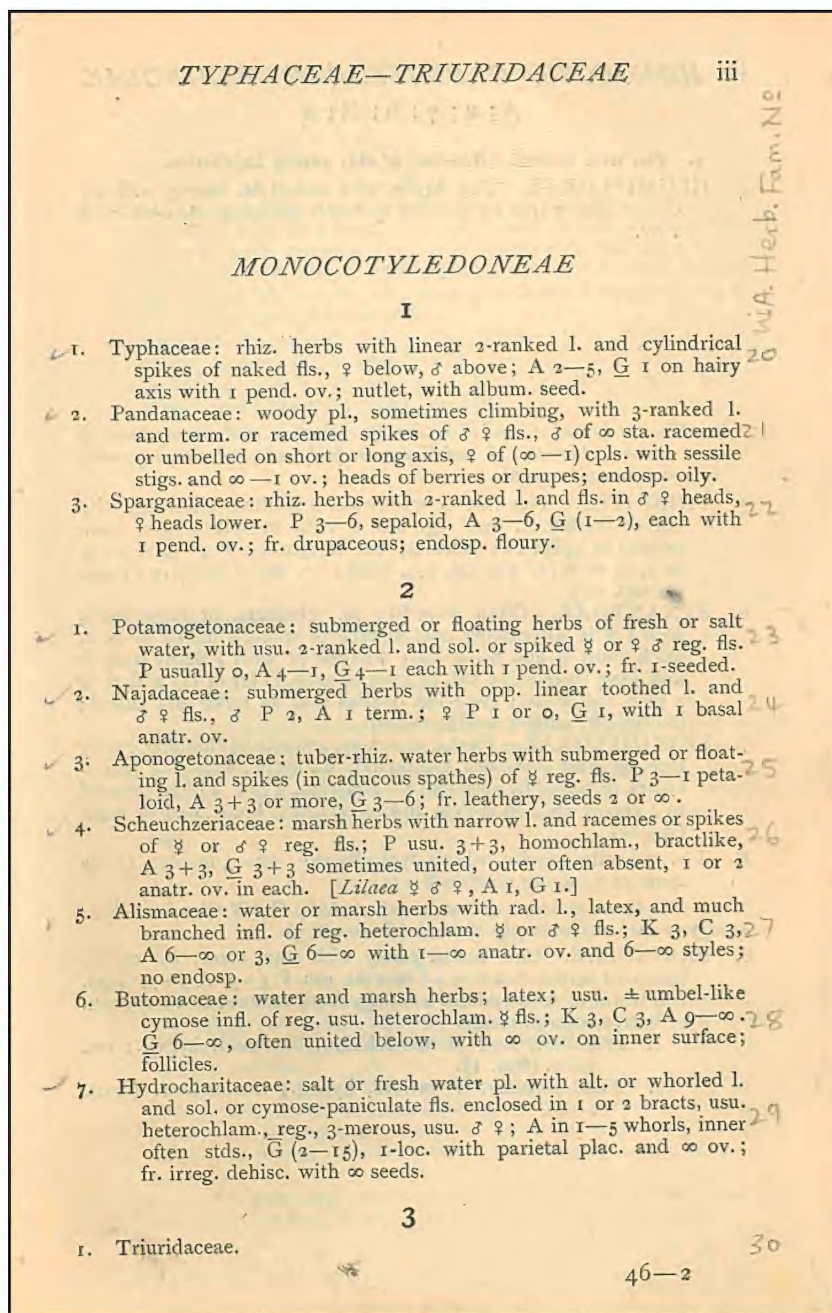


Figure 1. A copy of the 1919 4th edition of J.C. Willis' *A Dictionary of the Flowering Plants and Ferns* as annotated by C.A. Gardner, archived at the Department of Biodiversity, Conservation and Attractions Library, Perth.

In his *Enumeratio Plantarum Australiae Occidentalis*, Gardner (1930) only listed families and genera recorded for Western Australia, with the arrangement following Engler and Prantl (1887–1915), except for Leguminosae which he divided into three families (Mimosaceae, Caesalpiniaceae and Papilionaceae) as suggested by Hutchinson (1926) in his *The Families of Flowering Plants*. While families are not numbered in the publication, genera are numbered consecutively, again following Engler and Prantl (1887–1915).

A report written by Gardner (1947) states that the State Herbarium collection was arranged under the system adopted at the Herbarium of the Royal Botanic Gardens, Kew. Given the system adopted at Kew was based on Bentham and Hooker’s *Genera Plantarum* (1862–1883), it is assumed that Gardner is referring to the concept of a phylogenetic arrangement of families, rather than the specific Kew arrangement.

The family numbers used to assist the physical organisation of the State Herbarium derived from Engler and Prantl (1887–1915) were not consecutive, but they formed the basis for a Dewey-type decimal system for genera later adopted by Gardner sometime in the decade between 1930 and 1940. The decimal number was unique to the family (whole number) and genus (decimal). For example, the Guttiferae (now Clusiaceae) was given the decimal number 233.000, the Elatinaceae was given decimal number 235.000, while the family number 234.000 for Dipterocarpaceae was not represented in Western Australia (Appendix 1). Genera within families were allocated a unique consecutive number like 233.001, 233.002, and so on, with the arrangement of genera following the arrangement in Engler and Prantl (1887–1915) (Gardner 1930). In the rare cases where a genus was not recognised in Engler and Prantl (1887–1915), Gardner would have allocated a decimal number using available references and his own conclusion on its morphological or phylogenetic affinities. The ferns, fern allies, and gymnosperms were allocated the numbers 1.000 to 19.000. Monocotyledons started at 20.000 and finished with the Orchidaceae (66.000), and the dicotyledons from Casuarinaceae (70.000) to the Compositae (now Asteraceae) (345.000). While family numbering included families not naturally found within Western Australia, generic numbering was based on the order of genera as presented in Gardner (1930) (Table 1). Letter suffixes were subsequently added as new families and genera became recognised due to changes in taxonomic circumscription, such as the splitting of a family (e.g., Liliaceae (Green 1985)) (Appendix 1).

The collections remained unmounted prior to 1938, but as of July 1946, all were mounted (Gardner 1947). Until around 1955, outer brown folders had the genus name, handwritten mostly by Gardner, on the lower left-hand side, and the genus initial with specific epithet written on the lower right side (Neville Marchant, pers. comm.). The arrangement number, unique to the family (whole number) and genus (decimal), was in the centre. In 1955, as a new Herbarium Assistant, Neville Marchant was tasked with replacing all the old folders with new ones that were labelled using the then newly available UNO pens and plastic stencils (Figure 2).

Table 1. Example of the Englerian and decimal numbering system implemented by Gardner as demonstrated by Sterculiaceae (now Malvaceae) (family 223).

| Genus | Genus Number allocated in Engler & Prantl (1887–1915) | Order of listing in Gardner (1930) | Decimal number for Genus folders, and 1953 Herbarium Index |
|--------------------|---|------------------------------------|--|
| <i>Dicarpidium</i> | 13 | 4 th | 223.004 |
| <i>Waltheria</i> | 14 | 5 th | 223.005 |
| <i>Rulingia</i> | 15 | 6 th | 223.006 |
| <i>Commersonia</i> | 16 | 7 th | 223.007 |
| <i>Hannafordia</i> | 26 | 8 th | 223.008 |

The general arrangement of the collection within the 25 wooden cupboards in the State Observatory building has been documented (Figure 3). A bound herbarium index was typeset for the collections in order to physically locate taxa in cabinets and it was periodically updated based on taxonomic understanding at the time. Only the 1953 and 1959 editions remain. Constant reshuffling of specimens precluded the maintenance of these manually typed indexes until the advent of computer and database information technologies in the 1980s.

In 1957 the botanical collections of the Western Australian Museum were finally transferred to the State Herbarium and incorporated within the then designated arrangement. The State Herbarium was officially named as the Western Australian Herbarium, moved to the Department of Agriculture headquarters (B Block) in South Perth (1959–1970), and was given the *Index Herbariorum* (<http://sweetgum.nybg.org/science/ih/>) code PERTH in 1962.

In February 1981 John Green, then Curator of the Herbarium, published *Census of the Vascular Plants of Western Australia* (Green 1981) and for the first time the Gardner assigned family sequence numbers appeared formally in print (but not the genus numbers). Green (1985) followed this with a second edition and subsequent supplements.

In 1987, the Western Australian Herbarium was administratively transferred from the Department of Agriculture to the Department of Conservation and Land Management (CALM) (Fitzpatrick 2011). Changes in government resulted in subsequent administrative transfers to the Department of Environment and Conservation (2006–2013), Department of Parks and Wildlife (2013–2017), and now the Department of Biodiversity, Conservation and Attractions (2017–present).

By the 2000s, Gardner's arrangement was becoming increasingly out of step with the modern understanding of vascular plant systematics and the changing Herbarium strategic priorities. The Western Australian Herbarium was able to undertake a significant update to the arrangement of its collections as part of the move in 2009 to new premises at the Keiran McNamara Conservation Science Centre in Kensington. The collections were reorganised to largely reflect systematic relationships recognised by the Angiosperm Phylogeny Group (2009) following the linear sequence of Haston *et al.* (2009). The Gardner numbering system was disbanded, and the PERTH Linear Sequence Number (Appendix 1) was implemented only as a numerical system to manage taxon names data. The changes reflected the vastly improved modern knowledge of flowering plant relationships resulting from the Angiosperm Phylogeny Group projects (Angiosperm Phylogeny Group 1998, 2003, 2009) and other taxonomic work around the world. Along with the opportunity for reordering the physical collection, the taxonomic hierarchy within the associated Western Australian Plant Census database and collections management system was updated.

In 2018 the Herbarium implemented the APG IV (Angiosperm Phylogeny Group 2016) phylogenetic arrangement of families. Based on a wide range of evidence and repeatable analysis methods, this arrangement (Appendix 1), with several exceptions adopted by PERTH's Taxonomic Review Committee (TRC) following recommendations by specialists, is expected to remain relatively stable for the immediate future, although further changes are always possible as new evidence comes to light. The APG III (Angiosperm Phylogeny Group 2009) and APG IV (Angiosperm Phylogeny Group 2016) systems involved numerous family level changes. Some of these required the simple merging of one or more families whilst others necessitated more complex changes to family circumscriptions. Genera and species remain alphabetically arranged within a family for ease of collections management, particularly given the vast number of users of the collection that would find phylogenetic arrangement cumbersome and would result in increased misfiling of the collections.



Figure 2. An example of the annotation of brown outer folders with the genus name, family number and species drawn using the stencil, implemented after 1955. Family 163 was Mimosaceae (now Fabaceae), and the genus decimal no longer used. The pencil annotation is a curatorial addition.

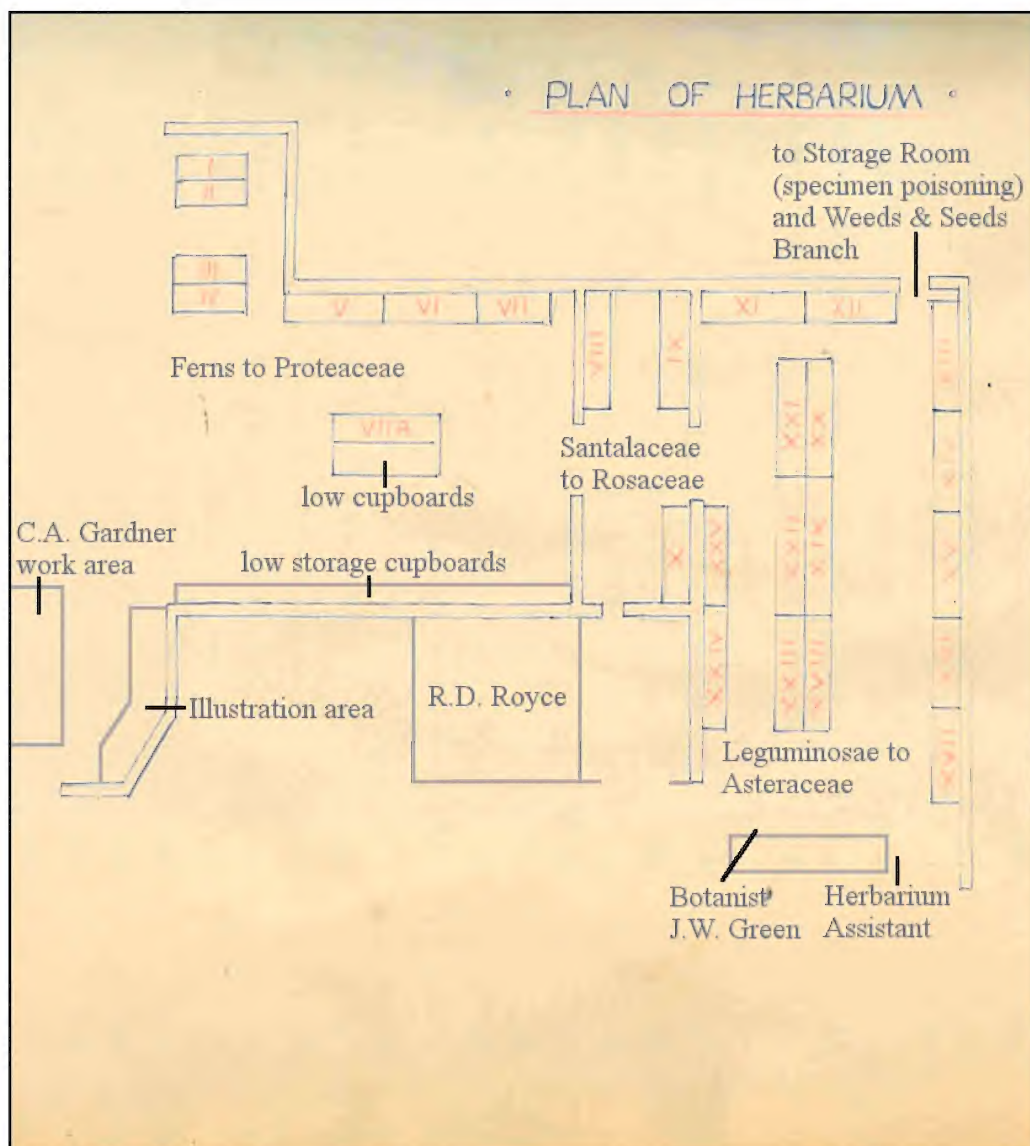


Figure 3. A sketch of the layout in the State Observatory Building, West Perth, around 1933–1959. At the time, herbarium specimens were housed in 25 wooden cabinets.

For the ferns, fern allies, and gymnosperms, PERTH previously utilised the arrangement as published in *Mabberley's Plant-Book* (Mabberley 2008). Mabberley (2008) in turn used Smith *et al.* (2006) as his reference for fern phylogeny. Most recently, the PPG I (Pteridophyte Phylogeny Group 2016) family linear sequence was published, which formed the basis for the classification of Australian fern taxa (Field 2020). The PPG I classification was implemented within the PERTH collections in 2020. Arrangements for gymnosperms follows Christenhusz *et al.* (2011).

The Western Australian Herbarium research collections are now housed in four main vaults (Figure 4), and a fifth smaller Types Vault. A sixth vault houses specimens on loan to PERTH. Herbarium indexes, similar to those in the former buildings, are produced electronically with location information for ease of specimen discovery within the collection spaces. In 2022, PERTH continues to replace now acidic folders with archival-quality pH-buffered folders, with taxon names being pencilled in the lower right corner of folders. The collection is secondarily arranged using coloured folders for Australian States and Territories and extra-Australian collections; further geographic division within Western Australia has not been uniformly implemented. Non-vascular plants, including algae, fungi, lichens, mosses, liverworts and hornworts, remain arranged alphabetically by genus due to continued high-level taxonomic instability and for ease of management. However, family circumscriptions currently (2022) follow that accepted by *AlgaeBase* (<https://www.algaebase.org/>), *The National Species List* (<https://biodiversity.org.au/nsll/>) and *Mycobank* (<https://www.mycobank.org/>).

The type and historical collections of the Western Australian Herbarium are separately housed within a dedicated vault, with increased security and fire protection. Both collections are alphabetically arranged by currently recognised families. The type collection is stored alphabetically by the typified name or basionym. Type specimens were originally housed as part of the main collections, and documented by way of a physical type register. Significant historical collections, made prior to 1829, such as those of Robert Brown, Joseph Banks and Daniel Solander, William Baxter, Allan Cunningham, James Drummond and Archibald Menzies, have also been relocated from the main collections due to their fragility and are stored alphabetically by currently accepted name in the Types Vault.

Several other collections within the Western Australian Herbarium are housed and arranged separately due to current management efficiencies. The wet or spirit collections are arranged by jar or bottle size and systematically by accession number. The carpological collection is stored in boxes at the end of the associated family. The type photographic collection is arranged in the same way as the type specimen collection but housed outside the Type Vault, photographic slides are arranged in filing cabinets, and digital images are stored within a Departmental digital repository. Microscope slide collections and molecular tissue collections are currently being developed and are not yet systematically arranged.

PERTH has adopted a 'punctuated equilibrium model' whereby future linear family rearrangements of the collections will be based on widely available collaborative taxonomic syntheses such as those mentioned here, best practice for storage, and community consensus rather than on the very latest research as it is published. Numbering systems are no longer implemented. In this way we can provide step-wise improvement in systematic knowledge while providing stable, documented research and reference collections. Appendix 1 and 2 list the vascular plant families that have been changed in Western Australia and the Herbarium over time (and hence as discoverable via the online platform *Florabase* (<https://florabase.dpaw.wa.gov.au/>)) and outline the most recently implemented classification and organisation of vascular plant families within the Western Australian Herbarium.

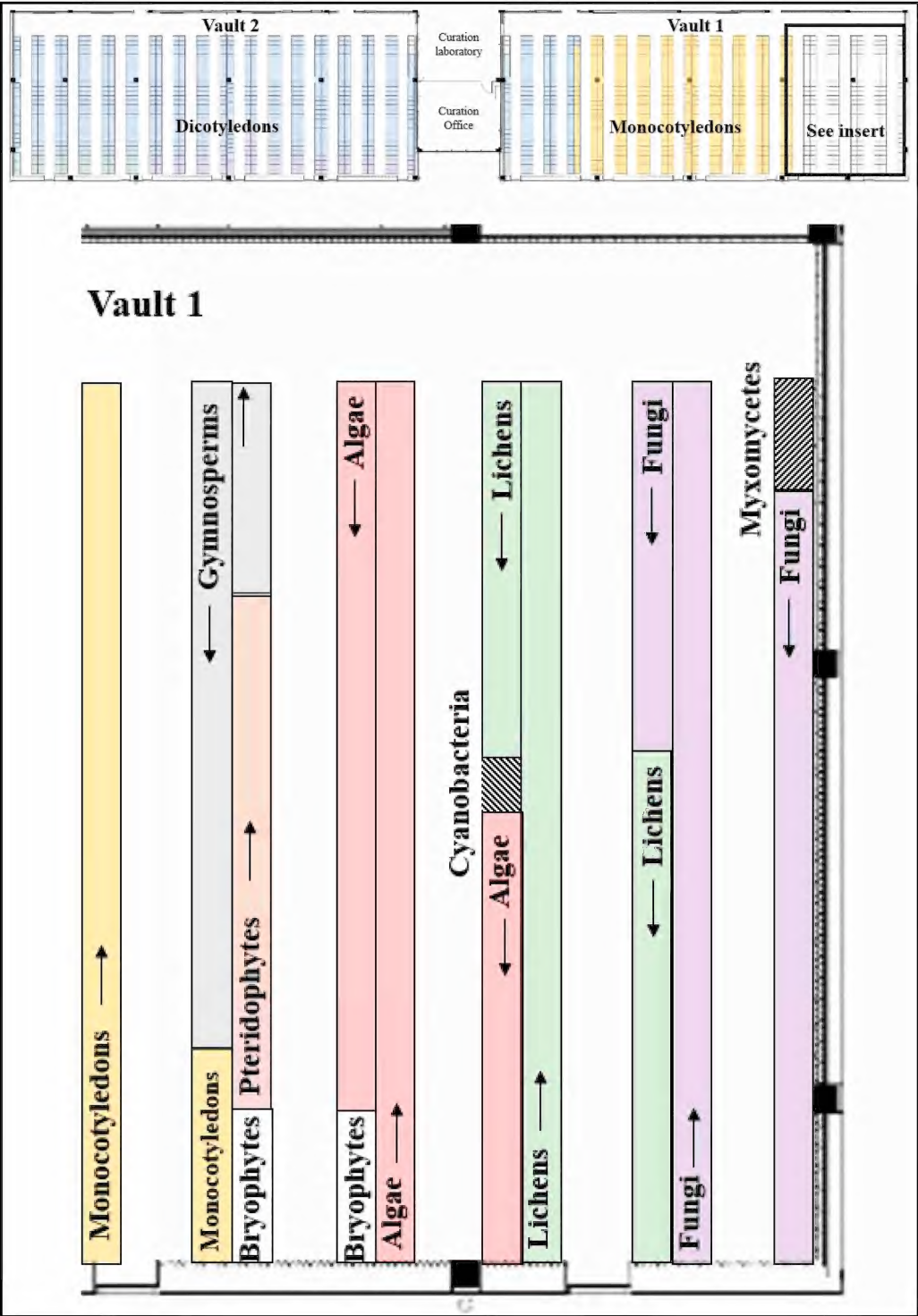


Figure 4. Floor plan of the Western Australian Herbarium in 2022 indicating the arrangement of the major plant groups. Only Vaults 1 and 2 (Floor 1) of the Keiran McNamara Conservation Science Centre are shown; Vaults 3 and 4 contain Dicotyledons only.

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We thank Neville Marchant for his helpful insights and memories of the Western Australian Herbarium. The authors would also like to thank Brendan Lepschi and Kelly Shepherd for their constructive comments on the manuscript. We also acknowledge and thank the Herbarium staff through the ages who have spent many an hour arranging and rearranging the collections to maintain their scientific value.

References

- Angiosperm Phylogeny Group (1998). An ordinal classification for the families of flowering plants. *Annals of the Missouri Botanical Garden* 85: 531–553.
- Angiosperm Phylogeny Group (2003). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. *Botanical Journal of the Linnean Society* 141: 399–436.
- Angiosperm Phylogeny Group (2009). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. *Botanical Journal of the Linnean Society* 161: 105–121.
- Angiosperm Phylogeny Group (2016). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of the Linnean Society* 181: 1–20.
- Bentham, G. & Hooker, J.D. (1862–1883). *Genera Plantarum*. (A. Black; L. Reeve & Co.: London.)
- Carne, W.M. (1925). *Report of the Economic Botanist and Plant Pathologist*. pp. 20–21. *1925 Annual Report*. Department of Agriculture, Western Australia. (Perth, Western Australia.)
- Carne, W.M. (1926). *Report of Botanist and Pathologist*. pp. 27–28. *1926 Annual Report*. Department of Agriculture, Western Australia. (Perth, Western Australia.)
- Christenhusz, M.J.M., Reveal, J.L., Farjon, A., Gardner, M.F., Mill, R.R. & Chase, M.W. (2011). A new classification and linear sequence of extant gymnosperms. *Phytotaxa* 19: 55–70.
- Engler, A. & Prantl, K. (1887–1915). *Die Natürlichen Pflanzenfamilien*. (W. Engelmann: Leipzig.)
- Field, A.R. (2020). Classification and typification of Australian lycophytes and ferns based on Pteridophyte Phylogeny Group classification PPG I. *Australian Systematic Botany* 33: 1–102.
- Fitzpatrick, E.N. (2011). *In response to need, a history of the Western Australian Department of Agriculture – 1894 to 2008*. (Department of Agriculture and Food WA: Perth, Western Australia.)
- Gardner, C.A. (1930). *Enumeration Plantarum Australiae Occidentalis: a systematic census of the plants occurring in Western Australia*. (Govt. Printer: Perth, Western Australia.)
- Gardner, C.A. (1947). The Western Australian State Herbarium. *Australasian Herbarium News* 1: 19–21.
- Green, J.W. (1981). *Census of the Vascular Plants of Western Australia*. (Western Australian Herbarium, Department of Agriculture: South Perth.)
- Green, J.W. (1985). *Census of the Vascular Plants of Western Australia*. 2nd edn. (Western Australian Herbarium, Department of Agriculture: South Perth.)
- Green, J.W. (1990). *History of early Western Australian Herbaria*. In: Short, P.S. (ed.) *History of Systematic Botany in Australia*. pp. 23–27. (Australian Systematic Botany Society Inc.: Victoria.)
- Haston, E., Richardson, J.E., Stevens, P.F., Chase, M.W. & Harris, D.J. (2009). The Linear Angiosperm Phylogeny Group (LAPG) III: a linear sequence of the families in APG III. *Botanical Journal of the Linnean Society* 161: 128–131.
- Hutchinson, J. (1926). *The Families of Flowering Plants. I. Dicotyledons arranged according to a new system based on their probable phylogeny*. (Macmillan: London.)
- Mabberley, D.J. (2008). *Mabberley's plant-book: a portable dictionary of plants, their classification and uses*. 3rd edn. (Cambridge University Press: Cambridge.)
- Pteridophyte Phylogeny Group (2016). A community-derived classification for extant lycophytes and ferns. *Journal of Systematics and Evolution* 54(6): 563–603.
- Smith, A.R., Pryer, K.M., Schuettpelz, E., Korall, P., Schneider, H. & Wolf, P.G. (2006). A classification for extant ferns. *Taxon* 55(3): 705–731.
- Stoward, F. (1913). *1913 Annual report / Department of Agriculture, Western Australia*. (Perth, Western Australia.)
- Underwood, R. (2011). *A botanical journey. The story of the Western Australian Herbarium*. (Department of Environment and Conservation: Perth, Western Australia.)
- Willis, J.C. (1919). *A Dictionary of the Flowering Plants and Ferns*. 4th edn. (Cambridge University Press: Cambridge.)

Appendix 1. The current PERTH Linear Sequence reflecting the phylogenetic arrangement for vascular plant families held in the Western Australian Herbarium in 2022 and summary of previous arrangements. * = not considered native or naturalised in Western Australia but represented in herbarium collections; ^ = excluded name, currently not regarded as occurring in WA; APG IV = Angiosperm Phylogeny Group (2016); PPG I = Pteridophyte Phylogeny Group (2016); TRC = Taxonomic Review Committee (PERTH); APC = Australian Plant Census. Note that the current linear sequence number is for internal data management; specimens are not annotated with these numbers. Missing numbers indicate a current lack of representation of those families at PERTH. Blue columns indicate the current arrangement at PERTH.

| Gardner annotation in Willis (1919) | PERTH Family Number [1953–1958] | PERTH Family Number [c. 1930– 2009] | PERTH Family [2010–2017] | PERTH Linear Sequence Number [2018–] | PERTH Family [2018–] | PERTH Order [2018–] | PERTH Source | Family in APG IV/PPG I/ Christenhusz <i>et al.</i> (2011) |
|---|---------------------------------------|---|-----------------------------|--|-------------------------|------------------------|-----------------|--|
| Fern allies | | | | | | | | |
| | 8,000 | 002 | Lycopodiaceae | 1 | Lycopodiaceae | Lycopodiales | PPG I | Lycopodiaceae |
| | 11,000 | 004 | Isoetaceae | 2 | Isoetaceae | Isoetales | PPG I | Isoetaceae |
| | 9,000 | 003 | Selaginellaceae | 3 | Selaginellaceae | Selaginellales | PPG I | Selaginellaceae |
| Ferns | | | | | | | | |
| | | 004A | | 4 | Equisetaceae * | Equisetales | PPG I | Equisetaceae |
| | 10,000 | 001 | Psilotaceae | 5 | Psilotaceae | Psilotales | PPG I | Psilotaceae |
| | 5,000 | 005 | Ophioglossaceae | 6 | Ophioglossaceae | Ophioglossales | PPG I | Ophioglossaceae |
| | | 006C | | 7 | Marattiaceae * | Marattiales | PPG I | Marattiaceae |
| | | 005A | | 8 | Osmundaceae * | Osmundales | PPG I | Osmundaceae |
| | | 013B | | 9 | Hymenophyllaceae * | Hymenophyllales | PPG I | Hymenophyllaceae |
| | 2,000 | 009 | Gleicheniaceae | 12 | Gleicheniaceae | Gleicheniales | PPG I | Gleicheniaceae |
| | | 006A | Lygodiaceae | 13 | Lygodiaceae | Schizaeales | PPG I | Lygodiaceae |
| | 4,000 | 006 | Schizaeaceae | 14 | Schizaeaceae | Schizaeales | PPG I | Schizaeaceae |
| | 7,000 | 014 | Salvinaceae | 16 | Salvinaceae | Salviniales | PPG I | Salvinaceae |
| | 6,000 | 013 | Marsileaceae | 17 | Marsileaceae | Salviniales | PPG I | Marsileaceae |
| | | 013A | | 24 | Dicksoniaceae * | Cyatheales | PPG I | Dicksoniaceae |

| Gardner annotation in Wil- lis (1919) | PERTH Family Number [1953–1958] | PERTH Family Number [c. 1930– 2009] | PERTH Family [2010–2017] | PERTH Linear Sequence Number [2018–] | PERTH Family [2018–] | PERTH Order [2018–] | PERTH Source | Family in APG IV/PPG I/ Christenhusz <i>et al.</i> (2011) |
|---|---------------------------------------|---|-----------------------------|--|-------------------------|------------------------|---|--|
| | | 011A | Cyatheaceae | 25 | Cyatheaceae | Cyatheales | PPG I | Cyatheaceae |
| | | 011D | Lindsaeaceae | 29 | Lindsaeaceae | Polypodiales | PPG I | Lindsaeaceae |
| | | 008 | Pteridaceae | 30 | Pteridaceae | Polypodiales | PPG I | Pteridaceae |
| | | 011C | Dennstaedtiaceae | 31 | Dennstaedtiaceae | Polypodiales | PPG I | Dennstaedtiaceae |
| | | 011E | Aspleniaceae | 37 | Aspleniaceae | Polypodiales | PPG I | Aspleniaceae |
| | | 012C | | 38 | | Polypodiales | PPG I | Woodsiaceae |
| | | 011G | Blechnaceae | 40 | Blechnaceae | Polypodiales | PPG I | Blechnaceae |
| | | 012B | | 41 | Athyriaceae * | Polypodiales | PPG I | Athyriaceae |
| | | 011B | Thelypteridaceae | 42 | Thelypteridaceae | Polypodiales | PPG I | Thelypteridaceae |
| | | 011F | Dryopteridaceae | 45 | Dryopteridaceae | Polypodiales | PPG I | Dryopteridaceae |
| | | | | 46 | Nephrolepidaceae | Polypodiales | PPG I | Nephrolepidaceae |
| | | 014B | Lomariopsidaceae | 47 | | Polypodiales | PPG I | Lomariopsidaceae |
| | | | | 48 | Tectariaceae * | Polypodiales | PPG I | Tectariaceae |
| | | 011H | | 49 | | Polypodiales | PPG I | Oleandraceae |
| | | 014A | | 50 | Davalliaceae * | Polypodiales | PPG I | Davalliaceae |
| | 1.000 | 010 | Polypodiaceae | 51 | Polypodiaceae | Polypodiales | PPG I | Polypodiaceae |
| Gymnosperms | | | | | | | | |
| | 14.000 | 016 | Cycadaceae | 52 | Cycadaceae | Cycadales | Christen- husz <i>et al.</i> (2011) | Cycadaceae |
| | | 016A | Zamiaceae | 53 | Zamiaceae | Cycadales | Christen- husz <i>et al.</i> (2011) | Zamiaceae |

| Gardner annotation in Wil- lis (1919) | PERTH Family Number [1953–1958] | PERTH Family Number [c. 1930– 2009] | PERTH Family [2010–2017] | PERTH Linear Sequence Number [2018–] | PERTH Family [2018–] | PERTH Order [2018–] | PERTH Source | Family in APG IV/PPG I/ Christenhusz <i>et al.</i> (2011) |
|---|---------------------------------------|---|-----------------------------|--|-------------------------|------------------------|---|--|
| | | | | 55 | | Pinales | Christen- husz <i>et al.</i> (2011) | Wetwitschiaceae |
| | | 017A | Pinaceae | 58 | Pinaceae | Pinales | Christen- husz <i>et al.</i> (2011) | Pinaceae |
| | 15,000 | 017 | Podocarpaceae | 60 | Podocarpaceae | Pinales | Christen- husz <i>et al.</i> (2011) | Podocarpaceae |
| | 16,000 | 018 | Cupressaceae | 62 | Cupressaceae | Pinales | Christen- husz <i>et al.</i> (2011) | Cupressaceae |
| | | 018 | | 63 | | Pinales | Christen- husz <i>et al.</i> (2011) | Taxaceae |
| Basal angiosperms | | | | | | | | |
| | | 040A | Hydatellaceae | 65 | Hydatellaceae | Nymphaeales | APG IV | Hydatellaceae |
| | | | | 66 | Cabombaceae * | Nymphaeales | APG IV | Cabombaceae |
| 115 | 115,000 | 115 | Nymphaeaceae | 67 | Nymphaeaceae | Nymphaeales | APG IV | Nymphaeaceae |
| | | | | 69 | Trimeniaceae * | Austrobaileyales | APG IV | Trimeniaceae |
| Magnoliids | | | | | | | | |
| | | 123A | | 72 | Winteraceae * | Caneliales | APG IV | Winteraceae |
| 71 | | | | 73 | | Piperales | APG IV | Saururaceae |
| 72 | | 072 | Piperaceae | 74 | Piperaceae | Piperales | APG IV | Piperaceae |
| 100 | | 100 | Aristolochiaceae | 75 | Aristolochiaceae | Piperales | APG IV | Aristolochiaceae |
| 128 | 128,000 | 128 | Myristicaceae | 76 | Myristicaceae | Magnoliales | APG IV | Myristicaceae |

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|---|---------------------------------------|---|-----------------------------|--|---------------------------|------------------------|-----------------|--|
| 123 | | 123 | | 77 | Magnoliaceae * | Magnoliales | APG IV | Magnoliaceae |
| 127 | | | | 80 | Eupomatiaceae * | Magnoliales | APG IV | Eupomatiaceae |
| 126 | | 126 | Annonaceae | 81 | Annonaceae | Magnoliales | APG IV | Annonaceae |
| 124 | | | | 82 | Calycanthaceae * | Laurales | APG IV | Calycanthaceae |
| 129 | | | | 84 | | Laurales | APG IV | Gomortegaceae |
| | | | | 85 | Atherospermata- ceae * | Laurales | APG IV | Atherospermataceae |
| 132 | 132.000 | 132 | Hernandiaceae | 86 | Hernandiaceae | Laurales | APG IV | Hernandiaceae |
| 130 | | 130 | | 87 | Monimiaceae * | Laurales | APG IV | Monimiaceae |
| 131 | 131.000 | 131 | Lauraceae | 88 | Lauraceae | Laurales | APG IV | Lauraceae |
| 73 | | | | 89 | | Chloranthales | APG IV | Chloranthaceae |
| Monocots | | | | | | | | |
| 35 | 35.000 | 035 | Araceae | 91 | Araceae | Alismatales | APG IV | Araceae |
| 27 | 27.000 | 027 | Alismataceae | 93 | Alismataceae | Alismatales | APG IV | Alismataceae |
| 28 | | 028 | | 94 | | Alismatales | APG IV | Butomaceae |
| 29 | 29.000 [as Vallisneriaceae] | 029 | Hydrocharitaceae | 95 | Hydrocharitaceae | Alismatales | APG IV | Hydrocharitaceae |
| 25 | 25.000 | 025 | Aponogetonaceae | 97 | Aponogetonaceae | Alismatales | APG IV | Aponogetonaceae |
| 26 [as Scheuchzeriaceae] | 26.000 [as Scheuchzeria- ceae] | 026 | Juncaginaceae | 98 | Juncaginaceae | Alismatales | APG IV | Juncaginaceae |
| | | 023D | Zosteraceae | 100 | Zosteraceae | Alismatales | APG IV | Zosteraceae |
| 23 | 23.000 | 023 | Potamogetonaceae | 101 | Potamogetonaceae | Alismatales | APG IV | Potamogetonaceae |
| | 23.000 | 023B | Posidoniaceae | 102 | Posidoniaceae | Alismatales | APG IV | Posidoniaceae |

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|---|---------------------------------------|---|-----------------------------|--|-------------------------|------------------------|-----------------|--|
| | 23,000 | 023E | Ruppiaceae | 103 | Ruppiaceae | Alismatales | APG IV | Ruppiaceae |
| | | 023C | Cymodoceaceae | 104 | Cymodoceaceae | Alismatales | APG IV | Cymodoceaceae |
| 65 | 65,000 | 065 | Burmanniaceae | 107 | Burmanniaceae | Dioscoreales | APG IV | Burmanniaceae |
| 58 | 58,000 | 058 | Taccaceae | 108 | Taccaceae | Dioscoreales | TRC | |
| 59 | 59,000 | 059 | Dioscoreaceae | 109 | Dioscoreaceae | Dioscoreales | APG IV | Dioscoreaceae |
| 30 | | | | 110 | | Pandanales | APG IV | Triuridaceae |
| 57 | | | | 111 | | Pandanales | APG IV | Velloziaceae |
| 53 | | 053 | Stemonaceae | 112 | Stemonaceae | Pandanales | APG IV | Stemonaceae |
| 34 | | | | 113 | | Pandanales | APG IV | Cyclanthaceae |
| 21 | 21,000 | 021 | Pandanaceae | 114 | Pandanaceae | Pandanales | APG IV | Pandanaceae |
| | | 054R | | 117 | Melanthiaceae * | Liliales | APG IV | Melanthiaceae |
| | | 054K | Alstroemeriaceae | 119 | Alstroemeriaceae | Liliales | APG IV | Alstroemeriaceae |
| | | 054J | Colchicaceae | 120 | Colchicaceae | Liliales | APG IV | Colchicaceae |
| | 54A,000 [as Philesiaceae] | | | 121 | | Liliales | APG IV | Philesiaceae |
| | | 054A | Smilacaceae | 123 | Smilacaceae | Liliales | APG IV | Smilacaceae |
| 54 | 54,000 | 054 | | 124 | Liliaceae | Liliales | APG IV | Liliaceae |
| 66 | 66,000 | 066 | Orchidaceae | 125 | Orchidaceae | Asparagales | APG IV | Orchidaceae |
| | | 054L | Boryaceae | 126 | Boryaceae | Asparagales | APG IV | Boryaceae |
| | | 054N | | 128 | Asteliaceae * | Asparagales | APG IV | Asteliaceae |
| | | 056A | Hypoxidaceae | 130 | Hypoxidaceae | Asparagales | APG IV | Hypoxidaceae |
| | | 055A | Tecophilaceae | 133 | Tecophilaceae | Asparagales | APG IV | Tecophilaceae |

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|---|---------------------------------------|---|-----------------------------|--|-------------------------|------------------------|-----------------|--|
| | | | | | | | | |
| 60 | 60,000 | 060 | Iridaceae | 134 | Iridaceae | Asparagales | APG IV | Iridaceae |
| | | 054D | Xanthorrhoeaceae | 136 | Xanthorrhoeaceae | Asparagales | TRC | |
| | | 054G | Asphodelaceae | 137 | Asphodelaceae | Asparagales | TRC | Asphodelaceae |
| | | 054P | Hemerocallida- ceae | 138 | Hemerocallidaceae | Asparagales | TRC | |
| 56 | 56,000 | 056 | Amaryllidaceae | 139 | Amaryllidaceae | Asparagales | APG IV | Amaryllidaceae |
| | | 054Q | Agapanthaceae | 140 | Agapanthaceae | Asparagales | TRC | |
| | | 054I | Alliaceae | 141 | Alliaceae | Asparagales | TRC | |
| | | 054B | Asparagaceae | 142 | Asparagaceae | Asparagales | APG IV | Asparagaceae |
| | | 054C | Dasyopogonaceae | 143 | Dasyopogonaceae | Arecales | APG IV | Dasyopogonaceae |
| 33 | 33,000 | 033 | Areaceae | 144 | Areaceae | Arecales | APG IV | Areaceae |
| [as Palmae] | [as Palmae] | | | | | | | |
| 47 | 47,000 | 047 | Commelinaceae | 146 | Commelinaceae | Commelinales | APG IV | Commelinaceae |
| 50 | 50,000 | 050 | Philydraceae | 147 | Philydraceae | Commelinales | APG IV | Philydraceae |
| 48 | 48,000 | 048 | Pontederiaceae | 148 | Pontederiaceae | Commelinales | APG IV | Pontederiaceae |
| 55 | 55,000 | 055 | Haemodoraceae | 149 | Haemodoraceae | Commelinales | APG IV | Haemodoraceae |
| | | | | 150 | Strelitziaceae * | Zingiberales | APG IV | Strelitziaceae |
| 61 | | 061 | Musaceae | 153 | Musaceae | Zingiberales | APG IV | Musaceae |
| 63 | | 063 | Cannaceae | 154 | Cannaceae | Zingiberales | APG IV | Cannaceae |
| 64 | | | Marantaceae | 155 | Marantaceae | Zingiberales | APG IV | Marantaceae |
| 62 | | | | 157 | | Zingiberales | APG IV | Zingiberaceae |
| 20 | 20,000 | 020 | Typhaceae | 158 | Typhaceae | Poales | APG IV | Typhaceae |
| 46 | | | | 159 | | Poales | APG IV | Bromeliaceae |

| Gardner annotation in Wil- lis (1919) | PERTH Family Number [1953–1958] | PERTH Family Number [c. 1930– 2009] | PERTH Family [2010–2017] | PERTH Linear Sequence Number [2018–] | PERTH Family [2018–] | PERTH Order [2018–] | PERTH Source | Family in APG IV/PPG I/ Christenhusz <i>et al.</i> (2011) |
|---|---------------------------------------|---|-----------------------------|--|-------------------------|------------------------|-----------------|--|
| 45 | | | | 160 | | Poales | APG IV | Rapateaceae |
| 42 | 42,000 | 042 | Xyridaceae | 161 | Xyridaceae | Poales | APG IV | Xyridaceae |
| 43 | 43,000 | 043 | Eriocaulaceae | 162 | Eriocaulaceae | Poales | APG IV | Eriocaulaceae |
| 41 | | | | 163 | | Poales | APG IV | Mayacaceae |
| 44 | | | | 164 | | Poales | APG IV | Thurniaceae |
| 52 | 52,000 | 052 | Juncaceae | 165 | Juncaceae | Poales | APG IV | Juncaceae |
| 32 | 32,000 | 032 | Cyperaceae | 166 | Cyperaceae | Poales | APG IV | Cyperaceae |
| 39 | 39,000 | 039 | Restionaceae | 167 | Restionaceae | Poales | APG IV | Restionaceae |
| | | 039B | Anarthriaceae | 168 | Anarthriaceae | Poales | TRC | |
| 40 | 40,000 | 040 | Centrolepidaceae | 169 | Centrolepidaceae | Poales | TRC | |
| 38 | 38,000 | 038 | Flagellariaceae | 170 | Flagellariaceae | Poales | APG IV | Flagellariaceae |
| | | 039A | Ecdiocolaceae | 172 | Ecdiocolaceae | Poales | APG IV | Ecdiocolaceae |
| 31 | 31,000 | 031 | Poaceae | 173 | Poaceae | Poales | APG IV | Poaceae |
| [as Gramineae] [as Gramineae] | | | | | | | | |
| Eudicots | | | | | | | | |
| 116 | | 116 | Ceratophyllaceae | 174 | Ceratophyllaceae | Ceratophyllales | APG IV | Ceratophyllaceae |
| 135 | 135,000 | 135 | Papaveraceae | 176 | Papaveraceae | Ranunculales | APG IV | Papaveraceae |
| 120 | | | | 178 | | Ranunculales | APG IV | Lardizabalaceae |
| 122 | 122,000 | 122 | Menispermaceae | 179 | Menispermaceae | Ranunculales | APG IV | Menispermaceae |
| 121 | | | | 180 | Berberidaceae | Ranunculales | APG IV | Berberidaceae |
| 119 | 119,000 | 119 | Ranunculaceae | 181 | Ranunculaceae | Ranunculales | APG IV | Ranunculaceae |
| 208 | | | | 182 | | Proteales | APG IV | Sabiaceae |
| | | 114 | Nelumbonaceae * | 183 | Nelumbonaceae * | Proteales | APG IV | Nelumbonaceae |

| Gardner annotation in Wil- lis (1919) | PERTH Family Number [1953–1958] | PERTH Family Number [c. 1930– 2009] | PERTH Family [2010–2017] | PERTH Linear Sequence Number [2018–] | PERTH Family [2018–] | PERTH Order [2018–] | PERTH Source | Family in APG IV/PPG I/ Christenhusz <i>et al.</i> (2011) |
|---|---------------------------------------|---|-----------------------------|--|-------------------------|------------------------|-----------------|--|
| 159 | | 159 | Platanaceae | 184 | Platanaceae | Proteales | APG IV | Platanaceae |
| 90 | 90.000 | 090 | Proteaceae | 185 | Proteaceae | Proteales | APG IV | Proteaceae |
| 117 | | | | 186 | | Trochodendrales | APG IV | Trochodendraceae |
| 190 | | | | 187 | | Buxales | APG IV | Buxaceae |
| Core eudicots | | | | | | | | |
| 226 | 226.000 | 226 | Dilleniaceae | 190 | Dilleniaceae | Dilleniales | APG IV | Dilleniaceae |
| Superrosids | | | | | | | | |
| 46 [as Bromeliaceae] | | 046 | | 193 | | Saxifragales | APG IV | Altingiaceae |
| 156 | | 156 | | 194 | Hamamelidaceae * | Saxifragales | APG IV | Hamamelidaceae |
| 118 | | | | 195 | | Saxifragales | APG IV | Cercidiphyllaceae |
| 151 | 151.000 | 151 | | 199 | Saxifragaceae * | Saxifragales | APG IV | Saxifragaceae |
| 149 | 149.000 | 149 | Crassulaceae | 200 | Crassulaceae | Saxifragales | APG IV | Crassulaceae |
| | | 155A | Aphanopetalaceae | 201 | Aphanopetalaceae | Saxifragales | APG IV | Aphanopetalaceae |
| 276 | 276.000 | 276 | Haloragaceae | 204 | Haloragaceae | Saxifragales | APG IV | Haloragaceae |
| Rosids | | | | | | | | |
| 216 | 216.000 | 216 | Vitaceae | 206 | Vitaceae | Vitales | APG IV | Vitaceae |
| 173 | 173.000 | 173 | Zygophyllaceae | 208 | Zygophyllaceae | Zygophyllales | APG IV | Zygophyllaceae |
| | | 162 | Fabaceae | 210 | Fabaceae | Fabales | APG IV | Fabaceae |
| | | 160A | Surianaceae | 211 | Surianaceae | Fabales | APG IV | Surianaceae |
| 183 | 183.000 | 183 | Polygalaceae | 212 | Polygalaceae | Fabales | APG IV | Polygalaceae |
| 161 | 161.000 | 161 | Rosaceae | 213 | Rosaceae | Rosales | APG IV | Rosaceae |
| 264 | | | | 216 | | Rosales | APG IV | Elaeagnaceae |

| Gardner annotation in Wil- lis (1919) | PERTH Family Number [1953–1958] | PERTH Family Number [c. 1930– 2009] | PERTH Family [2010–2017] | PERTH Linear Sequence Number [2018–] | PERTH Family [2018–] | PERTH Order [2018–] | PERTH Source | Family in APG IV/PPG I/ Christenhusz <i>et al.</i> (2011) |
|---|---------------------------------------|---|-----------------------------|--|-------------------------|------------------------|------------------|--|
| 215 | 215.000 | 215 | Rhamnaceae | 217 | Rhamnaceae | Rosales | APG IV | Rhamnaceae |
| 86 | 87.000 | 086 | | 218 | Ulmaceae | Rosales | APG IV | Ulmaceae |
| 87 | 87.000 [as Ulmaceae] | 086B 087 | Cannabaceae Moraceae | 219 220 | Cannabaceae Moraceae | Rosales Rosales | APG IV APG IV | Cannabaceae Moraceae |
| 88 | 88.000 | 088 | Urticaceae | 221 | Urticaceae | Rosales | APG IV | Urticaceae |
| 84 | | 085 | | 222 | Nothofagaceae * | Fagales | APG IV | Nothofagaceae |
| 77 | | 084 | | 223 | Fagaceae | Fagales | APG IV | Fagaceae |
| 80 | | 077 | | 224 | Myricaceae * | Fagales | APG IV | Myricaceae |
| 70 | 70.000 | 080 | | 225 | Juglandaceae * | Fagales | APG IV | Juglandaceae |
| 83 | | 070 | Casuarinaceae | 226 | Casuarinaceae | Fagales | APG IV | Casuarinaceae |
| 197 | | 101A | Apodanthaceae | 228 | | Fagales | APG IV | Betulaceae |
| 192 | | | | 229 | Apodanthaceae | Cucurbitales | APG IV | Apodanthaceae |
| 337 | 337.000 | 337 | Cucurbitaceae | 231 | | Cucurbitales | APG IV | Corynocarpaceae |
| 252 | | | | 232 | | Cucurbitales | APG IV | Coriariaceae |
| 253 | | | | 233 | Cucurbitaceae | Cucurbitales | APG IV | Cucurbitaceae |
| 199 | 199.000 | 199 | Celastraceae | 235 | | Cucurbitales | APG IV | Datisceae |
| 168 | 168.000 | 168 | Oxalidaceae | 236 | | Cucurbitales | APG IV | Begoniaceae |
| 155 | 155.000 | 155 | | 238 | Celastraceae | Celastrales | APG IV | Celastraceae |
| 217 | | 217 | Elaeocarpaceae | 241 | Oxalidaceae | Oxalidales | APG IV | Oxalidaceae |
| 150 | 150.000 | 150 | Cephalotaceae | 242 | Cunoniaceae * | Oxalidales | APG IV | Cunoniaceae |
| | | | | 243 | Elaeocarpaceae | Oxalidales | APG IV | Elaeocarpaceae |
| | | | | 244 | Cephalotaceae | Oxalidales | APG IV | Cephalotaceae |

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|---|---------------------------------------|---|-----------------------------|--|-------------------------|------------------------|-----------------|--|
| 153 | | | | 245 | | Oxalidales | APG IV | Burcellaceae |
| 166 | | | | 246 | | Malpighiales | APG IV | Pandaceae |
| 269 | 269.000 | 269 | Rhizophoraceae | 249 | Rhizophoraceae | Malpighiales | APG IV | Rhizophoraceae |
| 172 | | 172 | Erythroxylaceae | 250 | Erythroxylaceae | Malpighiales | APG IV | Erythroxylaceae |
| 228 | | | | 251 | | Malpighiales | APG IV | Ochnaceae |
| 233 [as Guttiferae] | 233.000 [as Guttiferae] | 233 | Clusiaceae | 253 | Clusiaceae | Malpighiales | APG IV | Clusiaceae |
| 140 | | 140 | Podostemaceae | 255 | Podostemaceae | Malpighiales | APG IV | Podostemaceae |
| 232 [as Theaceae] | | 232 | Hypericaceae | 256 | Hypericaceae | Malpighiales | APG IV | Hypericaceae |
| 229 | | | | 257 | | Malpighiales | APG IV | Caryocaraceae |
| | | 185C | Putranjivaceae | 259 | Putranjivaceae | Malpighiales | APG IV | Putranjivaceae |
| 235 | 235.000 | 235 | Elatinaceae | 261 | Elatinaceae | Malpighiales | APG IV | Elatinaceae |
| 179 | | 179 | | 262 | Malpighiaceae * | Malpighiales | APG IV | Malpighiaceae |
| 78 | | | | 263 | | Malpighiales | APG IV | Balanopaceae |
| 180 | | | | 264 | | Malpighiales | APG IV | Trigonaceae |
| 184 | | | | 265 | | Malpighiales | APG IV | Dichapetalaceae |
| | 161.000 | 161A | Chrysobalanaceae | 267 | Chrysobalanaceae | Malpighiales | APG IV | Chrysobalanaceae |
| 171 | | | | 268 | | Malpighiales | APG IV | Humiriaceae |
| 249 | | | | 269 | | Malpighiales | APG IV | Achariaceae |
| 243 | 243.000 | 243 | Violaceae | 270 | Violaceae | Malpighiales | APG IV | Violaceae |
| 248 | 248.000 | 248 | Passifloraceae | 272 | Passifloraceae | Malpighiales | APG IV | Passifloraceae |
| 246 | | 246 | Turneraceae | 273 | Turneraceae | Malpighiales | TRC | |

| Gardner annotation in Wil- lis (1919) | PERTH Family Number [1953–1958] | PERTH Family Number [c. 1930– 2009] | PERTH Family [2010–2017] | PERTH Linear Sequence Number [2018–] | PERTH Family [2018–] | PERTH Order [2018–] | PERTH Source | Family in APG IV/PPG I/ Christenhusz <i>et al.</i> (2011) |
|---|---------------------------------------|---|-----------------------------|--|-------------------------|------------------------|-----------------|--|
| 74 | | | | 274 | | Malpighiales | APG IV | Lacistemataceae |
| 75 | | 075 | Salicaceae | 275 | Salicaceae | Malpighiales | APG IV | Salicaceae |
| 101 | 101.000 | 101 | | 277 | | Malpighiales | APG IV | Rafflesiaceae |
| 185 | 185.000 | 185 | Euphorbiaceae | 278 | Euphorbiaceae | Malpighiales | APG IV | Euphorbiaceae |
| 170 | 170.000 | 170 | Linaceae | 279 | Linaceae | Malpighiales | APG IV | Linaceae |
| | | 185B | Picrodendraceae | 281 | Picrodendraceae | Malpighiales | APG IV | Picrodendraceae |
| | | 185A | Phyllanthaceae | 282 | Phyllanthaceae | Malpighiales | APG IV | Phyllanthaceae |
| 167 | 167.000 | 167 | Geraniaceae | 283 | Geraniaceae | Geraniales | APG IV | Geraniaceae |
| 209 | | | Melastomataceae | 284 | Francoaceae | Geraniales | APG IV | Francoaceae |
| 272 | 272.000 | 272 | Combretaceae | 285 | Combretaceae | Myrtales | APG IV | Combretaceae |
| 265 | 265.000 | 265 | Lythraceae | 286 | Lythraceae | Myrtales | APG IV | Lythraceae |
| 275 | 275.000 | 275 | Onagraceae | 287 | Onagraceae | Myrtales | APG IV | Onagraceae |
| 181 | | | | 288 | | Myrtales | APG IV | Vochysiaceae |
| 273 | 273.000 | 273 | Myrtaceae | 289 | Myrtaceae | Myrtales | APG IV | Myrtaceae |
| 274 | | 274 | Melastomataceae | 290 | Melastomataceae | Myrtales | APG IV | Melastomataceae |
| | | | | 291 | Crypteroniaceae * | Myrtales | APG IV | Crypteroniaceae |
| 261 | | | | 293 | | Myrtales | APG IV | Penaeaceae |
| 260 | | | | 295 | | Crossosomatales | APG IV | Geissolomataceae |
| 203 | | | | 297 | | Crossosomatales | APG IV | Staphyleaceae |
| 245 | | | | 299 | | Crossosomatales | APG IV | Stachyuraceae |
| 160 | | 160 | | 300 | | Crossosomatales | APG IV | Crossosomataceae |

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|---|---------------------------------------|---|-----------------------------|--|-------------------------|------------------------|-----------------|--|
| | | 175A | Nitriaceae | 307 | Nitriaceae | Sapindales | APG IV | Nitriaceae |
| 177 | 177.000 | 177 | Bursaceae | 309 | Bursaceae | Sapindales | APG IV | Bursaceae |
| 194 | 194.000 | 194 | Anacardiaceae | 310 | Anacardiaceae | Sapindales | APG IV | Anacardiaceae |
| 207 | 207.000 | 207 | Sapindaceae | 311 | Sapindaceae | Sapindales | APG IV | Sapindaceae |
| 175 | 175.000 | 175 | Rutaceae | 312 | Rutaceae | Sapindales | APG IV | Rutaceae |
| 176 | | 176 | Simaroubaceae | 313 | Simaroubaceae | Sapindales | APG IV | Simaroubaceae |
| 178 | 178.000 | 178 | Meliaceae | 314 | Meliaceae | Sapindales | APG IV | Meliaceae |
| | | 221A | | 316 | Muntingiaceae * | Malvales | APG IV | Muntingiaceae |
| 221 | 221.000 | 221 | Malvaceae | 318 | Malvaceae | Malvales | APG IV | Malvaceae |
| 263 | 263.000 | 263 | Thymelaeaceae | 320 | Thymelaeaceae | Malvales | APG IV | Thymelaeaceae |
| 240 | | 240 | Bixaceae | 321 | Bixaceae | Malvales | APG IV | Bixaceae |
| 239 | | | | 322 | | Malvales | APG IV | Cistaceae |
| 234 | | | | 324 | | Malvales | APG IV | Dipterocarpaceae |
| 169 | 169.000 | 169 | Tropaeolaceae | 326 | Tropaeolaceae | Brassicales | APG IV | Tropaeolaceae |
| 141 [Sarraceniaceae and Moringaceae] | | 141 | Moringaceae | 327 | Moringaceae | Brassicales | APG IV | Moringaceae |
| 250 | | 250 | | 328 | Caricaceae | Brassicales | APG IV | Caricaceae |
| 193 | | | | 329 | | Brassicales | APG IV | Limnanthaceae |
| 81 [as Batidaceae] | | 081 | Bataceae | 332 | Bataceae | Brassicales | APG IV | Bataceae |
| 201 | | | | 333 | | Brassicales | APG IV | Salvadoraceae |
| 137b | | 137B | Emblingiaceae | 334 | Emblingiaceae | Brassicales | APG IV | Emblingiaceae |
| 138a | | | | 335 | | Brassicales | APG IV | Tovariaceae |

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|--|---------------------------------------|---|-----------------------------|--|-------------------------|------------------------|-----------------|--|
| 108 | | 108 | Gyrostemonaceae | 337 | Gyrostemonaceae | Brassicales | APG IV | Gyrostemonaceae |
| 139 | | 139 | Resedaceae | 338 | Resedaceae | Brassicales | APG IV | Resedaceae |
| 137 [as orthographic variant Capparidaceae] | | 137A | Capparaceae | 339 | Capparaceae | Brassicales | APG IV | Capparaceae |
| 138 | | 137C | Cleomaceae | 340 | Cleomaceae | Brassicales | APG IV | Cleomaceae |
| 138 [as Cruciferae] | | 138 | Brassicaceae | 341 | Brassicaceae | Brassicales | APG IV | Brassicaceae |
| Superastrerids | | | | | | | | |
| 342 | | 342.000 | [as Brunonia- ceae] | 342 | | Berberidopsidales | APG IV | Aextoxicaceae |
| 95 | | 95.000 | Olacaceae | 344 | Olacaceae | Santalales | APG IV | Olacaceae |
| 93 | | 93.000 | Opiliaceae | 345 | Opiliaceae | Santalales | APG IV | Opiliaceae |
| 98 | | | | 346 | | Santalales | APG IV | Balanophoraceae |
| 92 | | 92.000 | Santalaceae | 347 | Santalaceae | Santalales | APG IV | Santalaceae |
| 97 | | 97.000 | Loranthaceae | 350 | Loranthaceae | Santalales | APG IV | Loranthaceae |
| 236 | | 236.000 | Frankeniaceae | 351 | Frankeniaceae | Caryophyllales | APG IV | Frankeniaceae |
| 237 | | 237 | Tamaricaceae | 352 | Tamaricaceae | Caryophyllales | APG IV | Tamaricaceae |
| 294 | | 294.000 | Plumbaginaceae | 353 | Plumbaginaceae | Caryophyllales | APG IV | Plumbaginaceae |
| 103 | | 103.000 | Polygonaceae | 354 | Polygonaceae | Caryophyllales | APG IV | Polygonaceae |
| 143 | | 143.000 | Droseraceae | 355 | Droseraceae | Caryophyllales | APG IV | Droseraceae |
| 142 | | 142 | | 356 | Nepenthaceae * | Caryophyllales | APG IV | Nepenthaceae |
| 254 | | | | 359 | | Caryophyllales | APG IV | Ancistrocladaceae |

| Gardner annotation in Wil- lis (1919) | PERTH Family Number [1953–1958] | PERTH Family Number [c. 1930– 2009] | PERTH Family [2010–2017] | PERTH Linear Sequence Number [2018–] | PERTH Family [2018–] | PERTH Order [2018–] | PERTH Source | Family in APG IV/PPG I/ Christenhusz <i>et al.</i> (2011) |
|---|---------------------------------------|---|-----------------------------|--|-------------------------|------------------------|-----------------|--|
| | | | | | | | | |
| | | 187 | | 361 | Simmondsiaceae * | Caryophyllales | APG IV | Simmondsiaceae |
| | | | | 364 | Macarthuriaceae | Caryophyllales | APG IV | Macarthuriaceae |
| 113 | 113.000 | 113 | Caryophyllaceae | 366 | Caryophyllaceae | Caryophyllales | APG IV | Caryophyllaceae |
| 106 | 106.000 | 106 | Amaranthaceae | 368 | Amaranthaceae | Caryophyllales | APG IV | Amaranthaceae |
| 105 | 105.000 | 105 | Chenopodiaceae | 369 | Chenopodiaceae | Caryophyllales | | |
| 110 | 110.000 | 110 | Aizoaceae | 376 | Aizoaceae | Caryophyllales | APG IV | Aizoaceae |
| 109 | 109.000 | 109 | Phytolaccaceae | 377 | Phytolaccaceae | Caryophyllales | APG IV | Phytolaccaceae |
| 107 | 107.000 | 107 | Nyctaginaceae | 380 | Nyctaginaceae | Caryophyllales | APG IV | Nyctaginaceae |
| | | 110A | Molluginaceae | 381 | Molluginaceae | Caryophyllales | APG IV | Molluginaceae |
| | | | | 382 | Montiaceae | Caryophyllales | APG IV | Montiaceae |
| | | 111A | | 383 | Didiereaceae | Caryophyllales | APG IV | Didiereaceae |
| 112 | | 112 | Basellaceae | 384 | Basellaceae | Caryophyllales | APG IV | Basellaceae |
| 111 | 111.000 | 111 | Portulacaceae | 387 | Portulacaceae | Caryophyllales | APG IV | Portulacaceae |
| | | | | 388 | Anacampserotaceae | Caryophyllales | APG IV | Anacampserotaceae |
| 256 | 256.000 | 256 | Cactaceae | 389 | Cactaceae | Caryophyllales | APG IV | Cactaceae |
| Asterids | | | | | | | | |
| 270 | | | | 390 | | Cornales | APG IV | Nyssaceae |
| 148 | | | | 391 | | Cornales | APG IV | Hydrostachyaceae |
| | | | Hydrangeaceae | 392 | Hydrangeaceae | Cornales | APG IV | Hydrangeaceae |
| 251 | | | | 393 | | Cornales | APG IV | Loasaceae |
| 94 | | | | 395 | Grubbiaceae * | Cornales | APG IV | Grubbiaceae |
| 282 | | | | 396 | | Cornales | APG IV | Cornaceae |

| Gardner annotation in Wil- lis (1919) | PERTH Family Number [1953–1958] | PERTH Family Number [c. 1930– 2009] | PERTH Family [2010–2017] | PERTH Linear Sequence Number [2018–] | PERTH Family [2018–] | PERTH Order [2018–] | PERTH Source | Family in APG IV/PPG I/ Christenhusz <i>et al.</i> (2011) |
|---|---------------------------------------|---|-----------------------------|--|-------------------------|------------------------|-----------------|--|
| 210 | | 210 | Balsaminaceae | 397 | Balsaminaceae | Ericales | APG IV | Balsaminaceae |
| 230 | | | | 398 | | Ericales | APG IV | Marcgraviaceae |
| 238 | | | | 400 | | Ericales | APG IV | Fouquieriaceae |
| 308 | 308,000 | 308 | Polemoniaceae | 401 | Polemoniaceae | Ericales | APG IV | Polemoniaceae |
| 268 | 268,000 | 268 | Lecythidaceae | 402 | Lecythidaceae | Ericales | APG IV | Lecythidaceae |
| 196 | | | | 404 | Pentaphragylacaceae * | Ericales | APG IV | Pentaphragylacaceae |
| 296 | 296,000 | 296 | Sapotaceae | 405 | Sapotaceae | Ericales | APG IV | Sapotaceae |
| 297 | 297,000 | 297 | Ebenaceae | 406 | Ebenaceae | Ericales | APG IV | Ebenaceae |
| 293 | 293,000 | 293 | Primulaceae | 407 | Primulaceae | Ericales | APG IV | Primulaceae |
| 298 | | 298 | | 409 | Symplocaceae * | Ericales | APG IV | Symplocaceae |
| 289 | | | | 410 | | Ericales | APG IV | Diapensiaceae |
| 299 | | | | 411 | | Ericales | APG IV | Styracaceae |
| 141 [Sarraceniaceae and Moringaceae] | | | | 412 | | Ericales | APG IV | Sarraceniaceae |
| 284 | | | | 415 | | Ericales | APG IV | Clethraceae |
| 195 | | | | 416 | | Ericales | APG IV | Cyrillaceae |
| 287 | | 287 | Ericaceae | 417 | Ericaceae | Ericales | APG IV | Ericaceae |
| 204 | | | | 420 | | leacinales | APG IV | leacinaceae |
| 158 | | | | 422 | | Garryales | APG IV | Eucommiaceae |
| 76 | | | | 423 | | Garryales | APG IV | Garryaceae |
| 331 | 331,000 | 331 | Rubiaceae | 424 | Rubiaceae | Gentianales | APG IV | Rubiaceae |
| 303 | 303,000 | 303 | Gentianaceae | 425 | Gentianaceae | Gentianales | APG IV | Gentianaceae |

| Gardner annotation in Wil- lis (1919) | PERTH Family Number [1953–1958] | PERTH Family Number [c. 1930– 2009] | PERTH Family [2010–2017] | PERTH Linear Sequence Number [2018–] | PERTH Family [2018–] | PERTH Order [2018–] | PERTH Source | Family in APG IV/PPG I/ Christenhusz <i>et al.</i> (2011) |
|---|---------------------------------------|---|-----------------------------|--|-------------------------|------------------------|-----------------|--|
| 302 | 302.000 | 302 | Loganiaceae | 426 | Loganiaceae | Gentianales | APG IV | Loganiaceae |
| 304 | 304.000 | 304 | Apocynaceae | 428 | Apocynaceae | Gentianales | APG IV | Apocynaceae |
| 310 | 310.000 | 310 | Boraginaceae | 429 | Boraginaceae | Boraginales | APG IV | Boraginaceae |
| 307 | 307.000 | 307 | Convolvulaceae | 431 | Convolvulaceae | Solanales | APG IV | Convolvulaceae |
| 315 | 315.000 | 315 | Solanaceae | 432 | Solanaceae | Solanales | APG IV | Solanaceae |
| 338 | | 338 | Sphenocleaceae | 434 | Sphenocleaceae | Solanales | APG IV | Sphenocleaceae |
| | | 314 | Hydroleaceae | 435 | Hydroleaceae | Solanales | APG IV | Hydroleaceae |
| 301 | 301.000 | 301 | Oleaceae | 438 | Oleaceae | Lamiales | APG IV | Oleaceae |
| | | 321A | Calceolariaceae | 440 | Calceolariaceae | Lamiales | APG IV | Calceolariaceae |
| 321 | | 321 | | 441 | Gesneriaceae * | Lamiales | APG IV | Gesneriaceae |
| 329 | 329.000 | 329 | Plantaginaceae | 442 | Plantaginaceae | Lamiales | APG IV | Plantaginaceae |
| 316 | 316.000 | 316 | Scrophulariaceae | 443 | Scrophulariaceae | Lamiales | APG IV | Scrophulariaceae |
| | | 330 | Linderniaceae | 445 | Linderniaceae | Lamiales | APG IV | Linderniaceae |
| 154 [as Myrothamnaceae] | 154.000 | 154 | Byblidaceae | 446 | Byblidaceae | Lamiales | APG IV | Byblidaceae |
| 319 | | 319 | Martyniaceae | 447 | Martyniaceae | Lamiales | APG IV | Martyniaceae |
| 318 | 318.000 | 318 | Pedaliaceae | 448 | Pedaliaceae | Lamiales | APG IV | Pedaliaceae |
| 325 | 325.000 | 325 | Acanthaceae | 449 | Acanthaceae | Lamiales | APG IV | Acanthaceae |
| 317 | 317.000 | 317 | Bignoniaceae | 450 | Bignoniaceae | Lamiales | APG IV | Bignoniaceae |
| 323 | 323.000 | 323 | Lentibulariaceae | 451 | Lentibulariaceae | Lamiales | APG IV | Lentibulariaceae |
| 311 | 311.000 | 311 | Verbenaceae | 454 | Verbenaceae | Lamiales | APG IV | Verbenaceae |
| 312 [as Labiatae] | 312.000 [as Labiatae] | 313 | Lamiaceae | 455 | Lamiaceae | Lamiales | APG IV | Lamiaceae |

| Gardner annotation in Wil- lis (1919) | PERTH Family Number [1953–1958] | PERTH Family Number [c. 1930– 2009] | PERTH Family [2010–2017] | PERTH Linear Sequence Number [2018–] | PERTH Family [2018–] | PERTH Order [2018–] | PERTH Source | Family in APG IV/PPG I/ Christenhusz <i>et al.</i> (2011) |
|---|---------------------------------------|---|-----------------------------|--|-------------------------|------------------------|-----------------|--|
| 327 | | 327 | Phrymaceae | 457 | Phrymaceae | Lamiales | APG IV | Phrymaceae |
| 320 | 320.000 | 320 | Orobanchaceae | 459 | Orobanchaceae | Lamiales | APG IV | Orobanchaceae |
| 198 | 198.000 | 198 | Aquifoliaceae | 464 | Aquifoliaceae | Aquifoliales | APG IV | Aquifoliaceae |
| | | 151C | | 465 | Rousseaceae * | Asterales | APG IV | Rousseaceae |
| 339 | 339.000 | 339 | Campanulaceae | 466 | Campanulaceae | Asterales | APG IV | Campanulaceae |
| 343 | 343.000 | 343 | Stylidiaceae | 468 | Stylidiaceae | Asterales | APG IV | Stylidiaceae |
| | | 343A | | 469 | Donatiaceae * | Asterales | TRC | |
| | | | | 470 | Alseuosmiaceae * | Asterales | APG IV | Alseuosmiaceae |
| | | | | 472 | Argophyllaceae * | Asterales | APG IV | Argophyllaceae |
| | | 303A | Menyanthaceae | 473 | Menyanthaceae | Asterales | APG IV | Menyanthaceae |
| 341 | 341.000 | 341 | Goodeniaceae | 474 | Goodeniaceae | Asterales | APG IV | Goodeniaceae |
| 344 | | | | 475 | | Asterales | APG IV | Calyceae |
| 345 | 345.000 [as Compositae] | 345 | Asteraceae | 476 | Asteraceae | Asterales | APG IV | Asteraceae |
| | | 151B | | 477 | Escalloniaceae * | Escalloniales | APG IV | Escalloniaceae |
| 322 | | 151A | Eremosynaceae | 478 | Eremosynaceae | Escalloniales | TRC | |
| | | | | 479 | | Bruniales | APG IV | Columelliaceae |
| 157 | | | | 480 | Bruniaceae * | Bruniales | APG IV | Bruniaceae |
| | | 154A | | 481 | Paracryphiaceae * | Paracryphiales | APG IV | Paracryphiaceae |
| 333 | | 333 | Adoxaceae * | 482 | Adoxaceae * | Dipsacales | APG IV | Adoxaceae |
| 332 | | 332 | Caprifoliaceae | 483 | Caprifoliaceae | Dipsacales | APG IV | Caprifoliaceae |

| Gardner annotation in Wil- lis (1919) | PERTH Family Number [1953–1958] | PERTH Family Number [c. 1930– 2009] | PERTH Family [2010–2017] | PERTH Linear Sequence Number [2018–] | PERTH Family [2018–] | PERTH Order [2018–] | PERTH Source | Family in APG IV/PPG I/ Christenhusz <i>et al.</i> (2011) |
|---|---------------------------------------|---|-----------------------------|--|-------------------------|------------------------|-----------------|--|
| 152 | 152.000 | 152 | Pittosporaceae | 487 | Pittosporaceae | Apiales | APG IV | Pittosporaceae |
| 280 | 280.000 | 280 | Araliaceae | 488 | Araliaceae | Apiales | APG IV | Araliaceae |
| 281 | 281.000 [as Umbelliferae] | 281 | Apiaceae | 490 | Apiaceae | Apiales | APG IV | Apiaceae |

Appendix 2. Summary of families synonymised during the APG II, III and IV (Angiosperm Phylogeny Group 2003; 2009; 2016) rearrangements with their historical numbers. For source of current family adopted at PERTH, see Appendix 1; * = not considered native or naturalised in Western Australia but represented in herbarium collections. Blue columns indicate the current arrangement at PERTH.

| Gardner annotation in Willis (1919) | PERTH Family Number [1953–1958] | PERTH Family Number [c. 1930–2009] | PERTH Family [c. 1930–2009] | PERTH Family [2018–] | PERTH Linear Sequence Number [2018–] |
|---|---------------------------------------|--|--------------------------------|-------------------------|--|
| | | 006B | Angiopteridaceae | Marattiaceae * | 7 |
| | | 007 | Adiantaceae | Pteridaceae | 30 |
| | 3.000 | 007A | Parkeriaceae | Pteridaceae | 30 |
| | | 008A | Vittariaceae | Pteridaceae | 30 |
| | | 009A | Grammitidaceae | Polypodiaceae | 51 |
| | | 009B | Platyzomataceae | Pteridaceae | 30 |
| | | 012A | Aspidiaceae | Dryopteridaceae | 45 |
| | | 015 | Azollaceae | Salvinaceae | 16 |
| | | 018A | Taxodiaceae | Cupressaceae | 62 |
| | | 023A | Zannichelliaceae | Potamogetonaceae | 101 |
| 24 | 24.000 | 024 | Najadaceae | Hydrocharitaceae | 95 |
| 36 | 36.000 | 036 | Lemnaceae | Araceae | 91 |
| | | 054E | Phormiaceae | Hemerocallidaceae | 138 |
| | | 054F | Anthericaceae | Asparagaceae | 142 |
| | | 054H | Hyacinthaceae | Asparagaceae | 142 |
| | | 054O | Trilliaceae | Melanthiaceae * | 117 |
| | | 056B | Agavaceae | Asparagaceae | 142 |
| | | 056C | Aloeaceae | Asphodelaceae | 137 |
| | | 097A | Viscaceae | Santalaceae | 347 |
| 136 | 136.000 | 136 | Fumariaceae | Papaveraceae | 176 |
| 163 | 163.000 | 163 | Mimosaceae | Fabaceae | 210 |
| 164 | 164.000 | 164 | Caesalpiniaceae | Fabaceae | 210 |
| 165 | 165.000 [as Leguminosae] | 165 | Papilionaceae | Fabaceae | 210 |
| 182 | 182.000 | 182 | Tremandraceae | Elaeocarpaceae | 243 |
| 186 | 186.000 | 186 | Callitrichaceae | Plantaginaceae | 442 |
| 200 | | 200 | Hippocrateaceae | Celastraceae | 238 |
| 202 | 202.000 | 202 | Stackhousiaceae | Celastraceae | 238 |
| 209 | | 209 | Melanthaceae | Francoaceae | 284 |
| 220 | 220.000 | 220 | Tiliaceae | Malvaceae | 318 |
| 222 | 222.000 | 222 | Bombacaceae | Malvaceae | 318 |
| 223 | 223.000 | 223 | Sterculiaceae | Malvaceae | 318 |
| 227 | | 227 | Eucryphiaceae | Cunoniaceae * | 242 |

| Gardner annotation in Willis (1919) | PERTH Family Number [1953–1958] | PERTH Family Number [c. 1930–2009] | PERTH Family [c. 1930–2009] | PERTH Family [2018–] | PERTH Linear Sequence Number [2018–] |
|--|--|---|--|---------------------------------|---|
| | | 006B | Angiopteridaceae | Marattiaceae * | 7 |
| | | 007 | Adiantaceae | Pteridaceae | 30 |
| | 3.000 | 007A | Parkeriaceae | Pteridaceae | 30 |
| | | 008A | Vittariaceae | Pteridaceae | 30 |
| | | 009A | Grammitidaceae | Polypodiaceae | 51 |
| | | 009B | Platyzomataceae | Pteridaceae | 30 |
| | | 012A | Aspidiaceae | Dryopteridaceae | 45 |
| | | 015 | Azollaceae | Salviniaceae | 16 |
| | | 018A | Taxodiaceae | Cupressaceae | 62 |
| | | 023A | Zannichelliaceae | Potamogetonaceae | 101 |
| 24 | 24.000 | 024 | Najadaceae | Hydrocharitaceae | 95 |
| 36 | 36.000 | 036 | Lemnaceae | Araceae | 91 |
| | | 054E | Phormiaceae | Hemerocallidaceae | 138 |
| | | 054F | Anthericaceae | Asparagaceae | 142 |
| | | 054H | Hyacinthaceae | Asparagaceae | 142 |
| | | 054O | Trilliaceae | Melanthiaceae * | 117 |
| | | 056B | Agavaceae | Asparagaceae | 142 |
| | | 056C | Aloeaceae | Asphodelaceae | 137 |
| | | 097A | Viscaceae | Santalaceae | 347 |
| 136 | 136.000 | 136 | Fumariaceae | Papaveraceae | 176 |
| 163 | 163.000 | 163 | Mimosaceae | Fabaceae | 210 |
| 164 | 164.000 | 164 | Caesalpiniaceae | Fabaceae | 210 |
| 165 | 165.000 [as Leguminosae] | 165 | Papilionaceae | Fabaceae | 210 |
| 182 | 182.000 | 182 | Tremandraceae | Elaeocarpaceae | 243 |
| 186 | 186.000 | 186 | Callitrichaceae | Plantaginaceae | 442 |
| 200 | | 200 | Hippocrateaceae | Celastraceae | 238 |
| 202 | 202.000 | 202 | Stackhousiaceae | Celastraceae | 238 |
| 209 | | 209 | Melanthaceae | Francoaceae | 284 |
| 220 | 220.000 | 220 | Tiliaceae | Malvaceae | 318 |
| 222 | 222.000 | 222 | Bombacaceae | Malvaceae | 318 |
| 223 | 223.000 | 223 | Sterculiaceae | Malvaceae | 318 |
| 227 | | 227 | Eucryphiaceae | Cunoniaceae * | 242 |
| 241 | 241.000 | 241 | Cochlospermaceae | Bixaceae | 321 |
| 244 | | 244 | Flacourtiaceae | Salicaceae | 275 |
| 266 | 266.000 | 267 | Sonneratiaceae | Lythraceae | 286 |

| Gardner annotation in Willis (1919) | PERTH Family Number [1953–1958] | PERTH Family Number [c. 1930–2009] | PERTH Family [c. 1930–2009] | PERTH Family [2018–] | PERTH Linear Sequence Number [2018–] |
|---|---------------------------------------|--|--------------------------------|-------------------------|--|
| 288 | 288.000 | 288 | Epacridaceae | Ericaceae | 417 |
| 291 | | 291 | Theophrastaceae | Primulaceae | 407 |
| 292 | 292.000 | 292 | Myrsinaceae | Primulaceae | 407 |
| | | 302A | Buddlejaceae | Scrophulariaceae | 443 |
| 305 | 305.000 | 305 | Asclepiadaceae | Apocynaceae | 428 |
| | | 307A | Cuscutaceae | Convolvulaceae | 431 |
| 309 | 309.000 | 309 | Hydrophyllaceae | Boraginaceae | 429 |
| | | 311A | Chloanthaceae | Lamiaceae | 455 |
| 312 | 311.000a | 312 | Avicenniaceae | Acanthaceae | 449 |
| 326 | 326.000 | 326 | Myoporaceae | Scrophulariaceae | 443 |
| 334 | | 334 | Valerianaceae | Caprifoliaceae | 483 |
| 336 | 336.000 | 336 | Dipsacaceae | Caprifoliaceae | 483 |
| 340 | 340.000 | 340 | Lobeliaceae | Campanulaceae | 466 |

The status of *Albizia lebbbeck* (Fabaceae: Mimosoideae) in Western Australia

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SHORT COMMUNICATION

The Raintree, Siris or Indian Siris (*Albizia lebbbeck* (L.) Benth.) occurs from east Africa through south-east Asia to northern Australia (Nielsen 1985). The species is widely planted in the tropics and is now pan-tropical in distribution and naturalised in many tropical countries, making its exact original range obscure (Nielsen 1985). As with many pan-tropical species this has made determining the status in Australia problematic. The species is currently listed as native to Western Australia, and the author was requested to attempt to ascertain whether weedy and native populations occur in the State as guidance for management in reserves, where the species was behaving as an invasive weed.

Status in Australia

Bentham (1864) in his *Flora Australiensis* treatment of *Albizia* recorded only *A. canescens* Benth., as native to Australia. He noted that *Albizia lebbbeck* was present around Brisbane (presumably cultivated, although not stated and no collection was cited). This has led to the species often being regarded as naturalised in Australia, including in the recent *Flora of Australia* treatment (Cowan 1998), where four species of *Albizia* are recorded as present in Australia and *A. lebbbeck* is listed as entirely naturalised with older and more recent introductions. However, Bentham was apparently unaware of a very early collection of *A. lebbbeck* from Careening and Brunswick Bay in the Kimberley of Western Australia made in 1820 by Allan Cunningham, the botanist with Phillip Parker King on the *Mermaid*. Duplicates of the collection *A. Cunningham* 301 are present in CANB (CANB 259077.1, *n.v.* and NSW 581819, photo seen!). Both of these collections were determined by Cowan for his treatment in the *Flora of Australia*. This is before European settlement of Northern Australia. Other later, but still early collections, were made from Thursday Island, Queensland in 1883 and 1885.

The species is now regarded as native to tropical Australia by most authorities and the current Australian Plant Census list (Council of Heads of Australasian Herbaria 2006–) gives the species as native and naturalized in Western Australia, native to the Northern Territory and naturalized for Queensland. Individual state and territory sources provide more detail and slightly different conclusions, as follows.

In the Northern Territory *A. lebbbeck* is listed as native (Dunlop *et al.* 1995), but uncommon in sandy coastal vine thickets (Liddle *et al.* 2004). In Queensland, *A. lebbbeck* is regarded as native only to

North Queensland (Cook Pastoral District, Cape York Peninsula), but widely naturalised outside the native range in north and east Queensland (Brown 2021). The species is noted as being particularly weedy around Charters Towers and Townsville. Naturalised material in Queensland is thought to have resulted from seed imported from Asia, most likely India (Zich *et al.* 2020).

Wheeler *et al.* (1992) noted that this species is probably native to Australia, hence Western Australia, but widely planted. *Florabase* (Western Australian Herbarium 1998–) followed this allocation, listing the species as native to Western Australia. Hussey *et al.* (2007) noted that *A. lebbeck* is native and naturalised in Western Australia.

Weed status World-wide

Albizia lebbeck is recorded as naturalised in tropical South America, United States (California and Florida), several Caribbean Islands, La Reunion and many Pacific Islands (Cook, Hawaii, Fiji, New Caledonia and Tonga). It is a serious and declared weed in Florida, Puerto Rico, Bahamas, Venezuela and South Africa (Randall 2017).

Status in Western Australia

The Kimberley Rainforest Survey (Kenneally *et al.* 1991) found that *A. lebbeck* was an uncommon component of sandy near-coastal vine thickets from the islands off the northern tip of the Dampier Peninsular and coastal sites west of Kalumburu. It is found in vine thickets on Kimberley islands (Lyons *et al.* 2014) from Sunday Island to Sir Graham Moore Island. Populations occur inland in scattered localities especially in the gorges of the Wuanaamin Miliwundi Ranges. Normally inland populations are found alongside rivers, rocky sites (limestone and basalt), but rarely in savanna woodland (perhaps because of frequent fires). An interesting common name for the species was noted for cultivated material at Kings Park Botanic Garden – Broome Rain Tree. Unfortunately, the species is not native to Broome; Kimberley Rain Tree would be a better choice.

This species, with other woody weeds such as *Leucaena leucocephala* (Lam.) de Wit, is proving to be a serious invasive species in the Darram Conservation Park, around Lake Kununurra. The management plan recorded *A. lebbeck* as present in over 326 hectares of the reserve (Ord Land and Water 2012), seeding prolifically from previous plantings especially after floods. The flat indehiscent pods are also widely dispersed by the wind especially during storms. *Albizia lebbeck* has been subject to removal from the Darram Conservation Park as a naturalised alien for over a decade.

Because the species was listed as native to Western Australia, the author was requested to attempt to ascertain and map weedy and native populations as guidance for management of these and other conservation reserves. Removal of a native species requires a formal clearing permit, unless the plants are adversely affecting conservation/biodiversity values of a reserve and there is an approved management plan that identifies the species as an issue. This issue is clarified in advice for the management of *Typha orientalis* C.Presl (Passaretto 2019).

Albizia lebbeck is widely planted throughout Western Australia, from Perth to Kununurra, including apparently widely as shade trees around homesteads on northern pastoral stations, as evidenced by collections from Lake Violet Station, Charnley River Homestead, Mount Elizabeth Station and Mitchell Plateau Mining Camp.

Naturalised populations are known from Exmouth: *G.J. Keighery & K. Lilburn s.n.* (BRI, PERTH 09428534, 09428526); Dampier: *G.J. & B.J. Keighery* 899 (PERTH 07851871); Port Hedland: *E.T. Bailey* 1-53 (PERTH 01653644); Broome: *L.S.J. Sweedman* 6967 (K *n.v.*, PERTH 08032637); Derby: *G.J. Keighery* 17503 (CANB, PERTH 09100318) and Kununurra: *T. Handasyde* TH 8288 (BRI *n.v.*, CANB *n.v.*, DNA *n.v.*, NSW *n.v.*, PERTH 09294325, 09294333), *I. Radford* IR *s.n.* (BRI *n.v.*, CANB *n.v.*, DNA *n.v.*, PERTH 09294309).

Characteristics of Alien *A. lebbbeck* (key characters for the naturalised plants are in bold)

Deciduous unarmed **tree, to 30 m**, in open sites forming a spreading habit, occasionally multi-stemmed, to 25 m tall and 30 m across with low branching. Capable of developing root suckers and densely coppicing from cut stumps. Bark rough, grey, flaky, inner bark reddish. Stems terete, green, puberulous-pubescent when young, rapidly becoming glabrous and grey-brown. Leaves bipinnate with (1-)2-4(-5) pairs of pinnae along a **rachis 8-9 cm long**. Pinnae comprise a rachilla 5-10 cm long, bearing 3-11 pairs of asymmetric (midrib closest to abaxial margin), oblong to elliptic-oblong **leaflets 4.5-6.5 cm long, 1.5-3.5 cm wide**, nycastic when young, fixed in older leaves. Inflorescence terminal or axillary and then often 2 or more per axil, consisting of a 5-9 cm diameter semi-globular cluster of 15-40 flowers; peduncles 5-10 cm long. Flowers fragrant; pedicels 1.5-4.5 mm long; calyx puberulous 3.5-5 mm long; corolla 5-11 mm long, terminating in 5 triangular lobes pubescent at apex; filaments numerous, 1.5-3 cm long, fused at the base, predominantly white to cream in colour, tipped pale green, becoming dark yellow with age. Pods flat, glabrous, coriaceous, indehiscent, **12-35 cm long, 4-8 cm wide**, undulating along sutures, light yellowish-brown when mature, containing 3-12 seeds. Seeds brown in colour, flattened, ellipsoidal, 6-11 mm long, 6-9 mm wide and 1-1.5 mm thick.

In general alien *A. lebbbeck* plants are single stemmed tall trees, with larger, longer leaves and leaflets that are always glabrous at maturity, compared to the native populations. Their canopies are dark green and dense compared to native plants. Their seed pods are also larger. However, these characteristics are only readily discernible in population samples. Some inland populations along rivers in the Kimberley are tall trees and are very difficult to allocate to native or naturalised plants.

As noted by Zich *et al.* (2020) it will become increasingly difficult to differentiate overseas and weedy populations in the future, unless a genetic marker can be found, making it essential that plantings of *A. lebbbeck* are not undertaken near native populations in conservation reserves.

Conclusions

In Western Australia *Albizia lebbbeck* should be regarded as native to the Kimberley, in the IBRA regions (Department of the Environment 2013) of Dampier, Central Kimberley and North Kimberley, but not the Ord-Victoria Plains or the Victoria-Bonaparte IBRA regions. Elsewhere in Western Australia and also in some situations within the native range as noted above, plants of the species are cultivated and/or naturalised and are probably of overseas origin. As a result, these populations have been annotated as 'Weedy Biotype' in PERTH collections. Thus, *Florabase* (Western Australian Herbarium 1998-) currently lists the species as both native and naturalised.

References

- Bentham, G. (1864). *Flora Australiensis*. Vol. 2: 421-423. (Reeve and Co.: London.)
- Brown, G.K. (December 2021). Fabaceae. In: Brown, G.K. (ed.) *Census of Queensland Flora 2021*. Queensland Department of Environment and Science, Brisbane. www.data.qld.gov.au/dataset/census-of-the-queensland-flora-2021 [accessed 1 April 2022].

- Council of Heads of Australasian Herbaria (2006–). *National Species List*. (<https://biodiversity.org.au>) [accessed 15 April 2022].
- Cowan, R.S. (1998). *Albizia*. In: McCarthy, P.M. (ed.) *Flora of Australia*. Vol. 12: Mimosaceae (excluding *Acacia*), Caesalpiniaceae. pp. 27–31. (Australian Biological Resources Study: Canberra / CSIRO Publishing: Melbourne.)
- Department of the Environment (2013). *Australia's bioregions (IBRA)*, IBRA7, Commonwealth of Australia. <https://www.awe.gov.au/agriculture-land/land/nrs/science/ibra#ibra> [accessed 20 March 2022].
- Dunlop, C.R., Leach, G.J. & Cowie, I.D. (1995). *Flora of the Darwin Region*. Northern Territory Botany Bulletin 20. (Conservation Commission of the Northern Territory.)
- Hussey, B.J.M., Keighery, G.J., Dodd, J., Lloyd, S.G. & Cousens, R.D. (2007). *Western Weeds*. 2nd edn. (Weeds Society of Western Australia: Victoria Park, Western Australia.)
- Kenneally, K.F., Keighery, G.J. & Hyland, B.F. (1991). Floristics and phytogeography of Kimberley Rainforests, Western Australia. In: McKenzie, N.L., Johnston, R.B. & Kendrick, P.G. (eds) *Kimberley Rainforests of Australia*. pp 93–131. (Surrey Beatty: Sydney.)
- Liddle, D.T., Russell-Smith, J., Brock, J., Leach, G.J. & Connors, G.T. (2004). Atlas of the Vascular Rainforest Plants of the Northern Territory. *Flora of Australia, Supplementary Series 3*. (Australian Biological Resources Study: Canberra.)
- Lyons, M.N., Keighery, G.J., Gibson, L.A. & Handasyde, T. (2014). Flora and vegetation communities of selected islands off the Kimberley coast of Western Australia. *Records of the Western Australian Museum, Supplement* 81: 205–243.
- Nielsen, I. (1985). The Malesian Species of *Acacia* and *Albizia* (Leguminosae-Mimosoideae). *Opera Botanica* 81: 1–50.
- Ord Land and Water (2012). Darram Conservation Park: Weed Management Plan. http://www.ohw.com.au/reports/darram_conservation_park.pdf. (Ord Land and Water and Department of Biodiversity, Conservation and Attractions: [Kununurra].)
- Passaretto, K. (2019). Reclassification of *Typha orientalis* as native to Western Australia and the implications under the Environmental Protection Act 1986 and the Swan and Canning Rivers Management Regulations. (Department of Biodiversity Conservation and Attractions: Como.)
- Randall, R.P. (2017). *A Global Compendium of Weeds*. 3rd edn. (R. Randall: Mount Helena, Western Australia.)
- Western Australian Herbarium (1998–). *Florabase—the Western Australian Flora*. Department of Biodiversity, Conservation and Attractions. <http://florabase.dbca.wa.gov.au/> [accessed 10 August 2021].
- Wheeler, J.R., Rye, B.L., Koch, B.L. & Wilson, A.J.G. (1992). *Flora of the Kimberley Region*. (Department of Conservation and Land Management: Como.)
- Zich, F.A., Hyland, B.P.M., Whiffin, T. & Kerrigan, R.A. (2020). *Albizia lebbeck*. Australian Tropical Rainforest Plants, 8th edn. <https://apps.lucidcentral.org/rainforest/> [accessed 12 April 2022].

**Reassessment of the type collections of W. Fitzgerald's
Calandrinia tepperiana (Montiaceae) leads to the discovery
of a putative new species from the Kimberley**

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SHORT COMMUNICATION

Obbens and Barrett (2018) reinstated *Calandrinia tepperiana* W.Fitzg. (Montiaceae) and selected a lectotype following examination of images of two Fitzgerald collections made from the May and Lennard Rivers ‘in grassy sandy spots’ (Fitzgerald 1918). The lectotype, ‘May River, near Poulton’s yards W.Fitzgerald 431’ (PERTH 09311009), was collected in the Dampierland bioregion on pindan country, which is characterised by plains with red, sandy soils. The remaining syntype, ‘6 miles NE of Mount Eliza, W.Fitzgerald 739’ (NSW, PERTH 09312102), was collected close to the Lennard River near its headwaters, on the western margin of the Central Kimberley bioregion. This site was very likely at the base or on the slopes of the Wunaamin Miliwundi Ranges (formerly the King Leopold Ranges), which is characterised by shallow sand over sandstone. The reinstatement of *C. tepperiana* and its lectotypification are not in question here; however, close examination of type material following its return from loan indicates that the Lennard River syntype represents an undescribed species.

The Lennard River syntype (PERTH 09312102) contains several plants with a good quantity of seed (note one plant will be removed to form a NSW duplicate), which is helpful, as seed characters are often diagnostic within *Calandrinia* Kunth (Carolin 1987; Syeda & Carolin 1989). The seeds of this syntype are circular in outline, narrowly elliptic in cross-section, mid to dark brown and smooth, and glossy. While the seeds of the lectotype of *C. tepperiana* are also mid to dark brown and glossy, they are distinctly different in being globular to sub-reniform in outline, and smooth to lightly colliculate. The Lennard River specimen appears closest to *C. uniflora* F.Muell. but differs from that species in having multi-flowered rather than single-flowered inflorescences and having brown rather than black seeds at maturity. The Lennard River syntype also appears to favour sandstone habitats while *C. uniflora* occurs near creeks, seepages, plains and low hillsides in a variety of soil types. Due to these differences, it is believed that this entity likely represents a potentially new taxon. Consequently, it has been phrase named *C. sp. Lennard River* (W. Fitzgerald 739) and added to Western Australia’s Vascular Plant Census database (Western Australian Herbarium 1998–); however, additional collections are required to facilitate its description. So far, only one other collection of this phrase-name species has been collected (PERTH 09312099), it being found in semi-scalded sandy area on sandstone plateau country. As *C. sp. Lennard River* (W. Fitzgerald 739) is currently only known from two populations it has been recently listed as Priority One under the Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–).

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References

- Carolin, R. (1987). A review of the family Portulacaceae. *Australian Journal of Botany* 35: 383–412.
- Fitzgerald, W. (1918). The Botany of the Kimberleys, North-West Australia. *Journal and Proceedings of the Royal Society of Western Australia* 3: 102–224.
- Obbens, F. & Barrett, M.D. (2018). Reinstatement and lectotypification of *Calandrinia tepperiana* (Montiaceae). *Nytsia* 29: 21–24.
- Syeda, S.T. & Carolin, R. (1989). Seed type and seed surface patterns in *Calandrinia sens. lat.* (Portulacaceae). *Proceedings of the Linnean Society of New South Wales* 110 (4): 307–316.
- Western Australian Herbarium (1998–). *Florabase—the Western Australian Flora*. Department of Biodiversity, Conservation and Attractions. <https://florabase.dpaw.wa.gov.au/> [accessed 7 June 2022]

An expanded circumscription and revision of the Western Australian genus *Balaustion* (Myrtaceae: Chamelaucieae: Hysterobaeckinae)

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Abstract

Rye, B.L. An expanded circumscription and revision of the Western Australian genus *Balaustion* (Myrtaceae: Chamelaucieae: Hysterobaeckinae). *Nuytsia* 33: 149–204 (2022). *Balaustion* Hook. *s. lat.* comprises 18 species that are characterised by having a large cavity on the inner surface of their seeds. Other characters found in all or most of the species are a low growth form, sub-epidermal tissue on the young stems that disintegrates into fibres, one-flowered peduncles, scarcely keeled sepals, and very large, sessile placentas. The type species of *Balaustion* has a distinctive anther type and particularly large, colourful flowers adapted to bird-pollination, but white is the most common petal colour in the genus. New combinations are made for three species previously included in *Baeckea* L. *s. lat.*: *Balaustion exsertum* (S.Moore) Rye, *B. grandibracteatum* (E.Pritz.) Rye and *B. grande* (E.Pritz.) Rye. A neotype is selected for *Baeckea grandibracteata* E.Pritz. and lectotypes chosen for *B. grandis* E.Pritz. and the type species *Balaustion pulcherrimum* Hook. The new species and subspecies are *B. baiocalyx* Rye, *B. bimucronatum* Rye, *B. filifolium* Rye, *B. grandibracteatum* subsp. *meridionale* Rye, *B. grandibracteatum* subsp. *juncturum* Rye, *B. hemisphaericum* Rye, *B. interruptum* Rye, *B. karroun* Rye, *B. muginbudin* Rye, *B. multicaule* Rye, *B. polyandrum* Rye, *B. quinquelobum* Rye, *B. spenceri* Rye, *B. tangerinum* Rye, *B. thamnoides* Rye and *B. unguiculatum* Rye. Most of these taxa are conservation-listed in Western Australia. Three sections are recognised: sect. *Balaustion* is monotypic, sect. *Nonfibrosa* Rye comprises three species with few ovules, and sect. *Tilophloia* Rye comprises 14 species characterised by stem tissue that tends to disintegrate into numerous fibres. One possible case of hybridisation between two of these sections is discussed.

Introduction

Balaustion Hook. *s. lat.* is a group of small, mostly low-growing shrubs that have one-flowered peduncles, sepals without horns or prominent ridges, seeds with a large cavity on the inner surface, and fruits with large, sessile placentas. Most species have very fibrous sub-epidermal tissue on the young stems. The genus belongs to subtribe Hysterobaeckinae Rye & Peter G. Wilson (Rye *et al.* 2020) and its type species, *B. pulcherrimum* Hook., has the largest flowers found in that subtribe. Evidence supporting the new circumscription of *Balaustion* adopted in this revision of the genus has been accumulating since 2002 and is outlined below.

Taxonomic history

James Drummond's discovery in the late 1840s of the very striking species known as Native Pomegranate created much interest. Within a few years the species had been named three times, first as *Balaustion pulcherrimum* Hook. (Hooker 1851), then as *Punicella carinata* Turcz. (Turczaninow 1852) and lastly as *Cheyenia pulchella* J.Drumm. ex Harv. (Harvey 1855). Bentham (1867) and Niedenzu (1893) found no difficulty in separating the monotypic *Balaustion s. str.* from the numerous and very varied species of *Baeckea* L. s. lat. in view of its conspicuous adaptations to bird-pollination.

Later-named species treated here as members of *Balaustion* were collected as inland areas suitable for agriculture were explored, resulting in the publication of three new species under *Baeckea*, *B. grandibracteata* E.Pritz., *B. grandis* E.Pritz. and *B. exserta* S.Moore, early in the twentieth century (Diels & Pritzel 1904; Moore 1920). Pritzel and Moore did not describe the distinctive seeds of these species, nor were they aware of any other morphological similarities between these taxa and *Balaustion pulcherrimum*. Gardner considered *Baeckea exserta* to be so closely related to *B. grandis* that he applied the name *B. grandis* var. *exserta* (S.Moore) C.A.Gardner ms to one specimen (PERTH 09116400) during the 1940s.

During the 1920s, a second bird-pollinated species belonging to subtribe Hysterobaeckeeinae was discovered. Like *Balaustion pulcherrimum*, it had large, brightly coloured, tubular flowers, numerous long stamens and a long style. Gardner (1927) had no hesitation in placing the new taxon in the same genus, naming it *Balaustion microphyllum* C.A.Gardner; however, this taxon was later transferred to the genus *Cheyeniana* Rye based on molecular data (Lam *et al.* 2002; Wilson *et al.* 2004) and differences in the morphology of the stamens, pollen, fruits and seeds (see Rye 2009a).

Balaustion has since remained monotypic, although Rye (2009a: 131, 137) drew attention to a close relationship between *Balaustion* and a group then known as '*Tilophloia* Trudgen & Rye ms', noting similarities in seed morphology and the following shared features: 'a low spreading habit, sepals without ridges or horns, stamens arranged in a single continuous circle, filaments broad and markedly flattened at the base, and very large placentas'. Further evidence given in support of this relationship was the presence of one specimen (*A.P. Brown* 3636) that seemed intermediate in morphology between *B. pulcherrimum* and '*Tilophloia* ms'.

A recent molecular phylogenetic analysis based on nr ETS and cp *trnK* and *atpB-rbcL* spacer sequences (Rye *et al.* 2020) supports the recognition of a more broadly circumscribed *Balaustion* that includes '*Tilophloia* ms'. In this study, *Balaustion s. lat.* formed a strongly supported clade with two Western Australian species and two eastern Australian genera, *Harmogia* Schauer and *Sanmantha* Peter G. Wilson, the latter genus also occurring in New Caledonia. The two Western Australian species, *Baeckea muricata* C.A.Gardner and *Baeckea* sp. Chapman Road (M.E. Trudgen MET 5446), were sister to *Balaustion s. lat.* They differ from *Balaustion* in having a muricate indumentum, strongly faceted seeds without a cavity, and up to four flowers per peduncle.

Harmogia was sister to the combined *Balaustion s. lat.*-*Baeckea muricata* group, with *Sanmantha* forming the outermost sister group. The eastern genera differ from *Balaustion* in several characters, including having stamens in antisepalous groups.

Manuscript names and phrase names

Although only three names have been validly published for members of *Balaustion s. lat.*, there have been several manuscript names and 27 phrase names applied to taxa now included in *Balaustion* (Table 1). The phrase names were established by Malcolm Trudgen, except for *Baeckea* sp. Diemals (A.P. Brown 3636) and *B. sp.* Yorkrakine (C.A. Gardner s.n. 09/1933), which were established during the early stages of the current study.

Methods

Sharr (2021) was consulted for the derivations for many of the previously published and new epithets. Measurements were made from herbarium specimens (in their dry state), using the largest leaves available and being careful to avoid immature floral organs, fruits and seeds. Mature style length was taken from old flowers or fruits and included the immersed base of the style. Sepal length was recorded from the largest sepals from each flower or fruit (i.e. avoiding the shorter sepals). Type material housed at PERTH or on loan from BM was examined, and images of types housed elsewhere were examined through *Global Plants* (<https://plants.jstor.org/>).

As in the treatments of *Hypocalymma* (Rye *et al.* 2013) and *Rinzia* (Rye 2017), a policy of recognising sections within a single genus rather than several smaller, new genera was adopted for *Balaustion*. This was to allow the morphological discontinuities within *Balaustion s. lat.* to be clearly recognised without obscuring the close relationships between the morphological groups.

Morphology

Various aspects of the morphology of the largest group, sect. *Tilophloia* Rye, are illustrated in Figure 1, including some characters of importance in the keys.

Habit and stems. Sections *Balaustion* and *Tilophloia* comprise prostrate or low-growing shrubs that are mostly 0.15–0.8 m high, except for *B. thamnoides* Rye which is 0.7–1.2 m high. Section *Nonfibrosa* Rye has a greater range of heights, up to 1.7 m, but still with a tendency towards a low-growing, widely spreading habit, with taller shrubs being more straggly. The sole member of sect. *Balaustion*, *B. pulcherrimum*, appears to be the only species that produces adventitious roots from its prostrate stems (Rye 2009a: Figure 1A) and has its flowers borne on the ground (Figure 2).

A characteristic feature of sect. *Tilophloia* is the highly fibrous sub-epidermal tissue of the young stems. As the epidermis is shed, the sub-epidermal tissue disintegrates into numerous fine fibres (Figure 1A). This character is seen to a lesser degree in sect. *Balaustion*, whereas sect. *Nonfibrosa* has the epidermis and sub-epidermal tissue peeling off in strips.

Leaves. *Balaustion pulcherrimum* is unique in having leaves with a white apical point 0.15–0.3 mm long (Rye 2009a: Figure 1B). The three species of sect. *Nonfibrosa* have thicker leaves with an obtuse or truncate apex and a scarious border that is denticulate or entire. Many members of sect. *Tilophloia* have leaves with a keel that is strongly ridged towards the apex or projected into a small subterminal point (Figure 1A–D). The tip of the leaf (from side view) may have a 2-pointed shape with a vertical or oblique concave area in between the apical mucro and the subterminal one (Figure 1C), but often becomes truncate in older leaves. The apex itself is never prominently pointed in sect. *Tilophloia*; the mucro (when present) is less than 0.1 mm long. Other species of sect. *Tilophloia* have a keel that is rounded at the apex (Figure 1E & F).

Table 1. Phrase names, manuscript names and published names for taxa belonging to *Balaustion s. lat.*, with the years they were established and their new names.

| Old name | Year | New name |
|--|-------|--|
| <i>Baeckea cryptonoma</i> Trudgen ms | 1994 | <i>Balaustion interruptum</i> Rye |
| <i>Baeckea exserta</i> S.Moore | 1920 | <i>Balaustion exsertum</i> (S.Moore) Rye |
| <i>Baeckea grandibracteata</i> E.Pritz. | 1904 | <i>Balaustion grandibracteatum</i> (E.Pritz.) Rye |
| <i>Baeckea grandibracteata</i> subsp. Parker Range (K. Newbey 9270) | 2007 | <i>Balaustion grandibracteatum</i> (E.Pritz.) Rye subsp. <i>grandibracteatum</i> |
| <i>Baeckea grandis</i> E.Pritz. | 1904 | <i>Balaustion grande</i> (E.Pritz.) Rye |
| <i>Baeckea grandis</i> var. <i>brevifolia</i> C.A.Gardner ms | 1930s | <i>Balaustion grande</i> (E.Pritz.) Rye |
| <i>Baeckea grandis</i> var. <i>exserta</i> (S.Moore) C.A.Gardner ms | 1940 | misapplied to <i>Balaustion quinquelobum</i> Rye |
| <i>Baeckea grandis</i> var. <i>minor</i> W.E.Blackall <i>nom. nud.</i> | 1954 | <i>Balaustion grande</i> (E.Pritz.) Rye |
| <i>Baeckea rosea</i> Trudgen ms | 1990s | <i>Balaustion quinquelobum</i> Rye |
| <i>Baeckea</i> sp. Baladjie (P.J. Spencer 24) | 2004 | <i>Balaustion spenceri</i> Rye |
| <i>Baeckea</i> sp. Beringbooding (A.R. Main 11/9/1957) | 2004 | <i>Balaustion filifolium</i> Rye |
| <i>Baeckea</i> sp. Billyacatting Hill (A.S. George 14349) | 2004 | <i>Balaustion</i> sp. Billyacatting Hill (A.S. George 14349) |
| <i>Baeckea</i> sp. Blue Haze Mine (P. Armstrong 06/910) | 2007 | <i>Balaustion grandibracteatum</i> subsp. <i>juncturum</i> Rye |
| <i>Baeckea</i> sp. Burakin (M.E. & M.E. Trudgen 1423) | 2010 | <i>Balaustion interruptum</i> Rye |
| <i>Baeckea</i> sp. Crossroads (B.L. Rye & M.E. Trudgen 241186) | 2007 | <i>Balaustion grandibracteatum</i> subsp. <i>juncturum</i> Rye |
| <i>Baeckea</i> sp. Diemals (A.P. Brown 3636) | 2008 | <i>Balaustion tangerinum</i> Rye |
| <i>Baeckea</i> sp. Elsewhere Road (M.E. Trudgen 5420) | 2004 | <i>Balaustion mukinbudin</i> Rye |
| <i>Baeckea</i> sp. Eujinyin (J. Buegge D 99) | 2005 | <i>Balaustion exsertum</i> (S.Moore) Rye |
| <i>Baeckea</i> sp. Forrestania (K.R. Newbey 1105) | 2004 | <i>Balaustion grandibracteatum</i> subsp. <i>juncturum</i> Rye |
| <i>Baeckea</i> sp. Hatter Hill (K.R. Newbey 3284) | 2004 | <i>Balaustion thamnoides</i> Rye |
| <i>Baeckea</i> sp. Jaurdi Station (L.W. Sage & F. Hort 2229) | 2004 | <i>Balaustion polyandrum</i> Rye |
| <i>Baeckea</i> sp. Kellerberrin (C.A. Gardner s.n. PERTH 03351009) | 2005 | <i>Balaustion exsertum</i> (S.Moore) Rye |
| <i>Baeckea</i> sp. Koonadgin (B.L. Rye & M.E. Trudgen BLR 241137) | 2010 | <i>Balaustion quinquelobum</i> Rye |
| <i>Baeckea</i> sp. Koorda (W.E. Blackall 3371) | 2004 | <i>Balaustion baiocalyx</i> Rye |
| <i>Baeckea</i> sp. Lake Cronin (K.R. Newbey 9191) | 2004 | <i>Balaustion</i> sp. North Ironcap (R.J. Cranfield 10580) |
| <i>Baeckea</i> sp. Mt Gibbs (G.F. Craig 7031) | 2007 | <i>Balaustion grandibracteatum</i> subsp. <i>meridionale</i> Rye |
| <i>Baeckea</i> sp. Mt Glasse (P.G. Wilson 5717) | 2004 | <i>Balaustion grandibracteatum</i> subsp. <i>meridionale</i> Rye |
| <i>Baeckea</i> sp. Muntadgin (E.T. Bailey 231) | 2004 | <i>Balaustion quinquelobum</i> Rye |
| <i>Baeckea</i> sp. North Ironcap (R.J. Cranfield 10580) | 2004 | <i>Balaustion</i> sp. North Ironcap (R.J. Cranfield 10580) |
| <i>Baeckea</i> sp. Sheoaks Rocks (M.E. Trudgen 5452) | 2004 | <i>Balaustion multicaule</i> Rye |
| <i>Baeckea</i> sp. Stockton Road (M.E. Trudgen MET22077 & B. Rye) | 2004 | <i>Balaustion bimucronatum</i> Rye |

| Old name | Year | New name |
|---|------|--|
| <i>Baeckea</i> sp. Tammin (R. Coveny 8319 & B. Habberley) | 2004 | <i>Balaustion exsertum</i> (S.Moore) Rye |
| <i>Baeckea</i> sp. Tampia Hill (J.C. Anway 327) | 2004 | <i>Balaustion exsertum</i> (S.Moore) Rye |
| <i>Baeckea</i> sp. Wialki (G.M. Storr s.n. 4/10/1958) | 2004 | <i>Balaustion karroun</i> Rye |
| <i>Baeckea</i> sp. Yacke Yackine Dam (K.R. Newbey 9195) | 2004 | <i>Balaustion unguiculatum</i> Rye |
| <i>Baeckea</i> sp. Yorkrakine (C.A. Gardner s.n. 09/1933) | 2004 | <i>Balaustion</i> sp. Yorkrakine (C.A. Gardner s.n. 09/1933) |

Inflorescence. Flowering branchlets commonly have just one flower-bearing node, with a single 1-flowered peduncle in the axil of each of the two leaves borne at this node. Sometimes one flower at the node fails to be initiated or aborts, particularly in very low-growing species with horizontal stems; hence many nodes may have just a solitary flower. In three species there are up to about six flower-bearing nodes on a flowering branchlet, but the nodes may be separated by sterile nodes. Widely spaced pairs of flowers and solitary flowers are characteristic of the genus and dense clusters of flowers are absent except occasionally in sect. *Nonfibrosa*. The flower bud (Figure 1G) is subtended by two bracteoles, which are often borne close below the base of the flower with little or no pedicel in between. However, in a few taxa the pedicels tend to be of a similar length to the peduncles, and *B. grande* (E.Pritz.) Rye has pedicels usually much longer than the peduncles. A typical-looking flower for sect. *Tilophloia* is illustrated in Figure 1H.

Bracteoles. Sections *Balaustion* and *Nonfibrosa* have persistent bracteoles that are much shorter than the mature flower buds. Within sect. *Tilophloia*, three species have very large bracteoles that enclose the buds up until anthesis and often persist even in late fruit (Figure 1I & J). In these taxa the bracteoles are very scarious (papery), readily torn and lack a prominent keel. Several taxa including *B. exsertum* have prominently keeled and somewhat more herbaceous bracteoles that enclose the younger buds and are widely antrorse to patent when the flowers open, persisting into the fruiting stage. Another group of taxa has caducous bracteoles that are only seen on the young buds. A few taxa are too variable to strictly belong in any of these three categories.

Calyx and corolla. The sepals are never prominently keeled or horned, and often have a pale border (Figure 1H). They are always much shorter than the petals and usually shorter than the stamens. Most species have petals 3–7 mm long that are white or pale pink on the inner surface. If such species have buds enclosed in bracteoles until just before the flowers open, the petals are uniformly coloured outside, but if the buds are exposed at an early stage, the outer petals are blotched with deep pink outside. Two taxa that appear to be adapted to bird-pollination have orange to red petals 7–10 mm long and stamens of a similar length (6.5–11 mm). Among the white- and pink-flowered species the petals are usually longer, up to three times longer, than the stamen filaments.

Androecium. Stamen numbers range from 13 to 35 and are variable within every species of *Balaustion*, but a fairly common stamen arrangement in the genus has one stamen opposite (but not necessarily exactly at the centre of) each sepal and petal, and one at each position between the sepals and petals, giving a total of 20 stamens (Figure 1H). Staminodes are absent or rare. In *B. grande*, the stamens are all united at the base into a short tube. At the other extreme, *B. hemisphaericum* Rye and *B. interruptum* Rye have narrow filaments and large gaps between some or all of them. In all other taxa, the stamens are all or mostly free, with the filaments broad at the base and contiguous or with narrow gaps between adjacent ones (Figure 1H). Broad filaments often have a slender midvein visible. Filaments are white or pale pink, sometimes with a darker pink base.

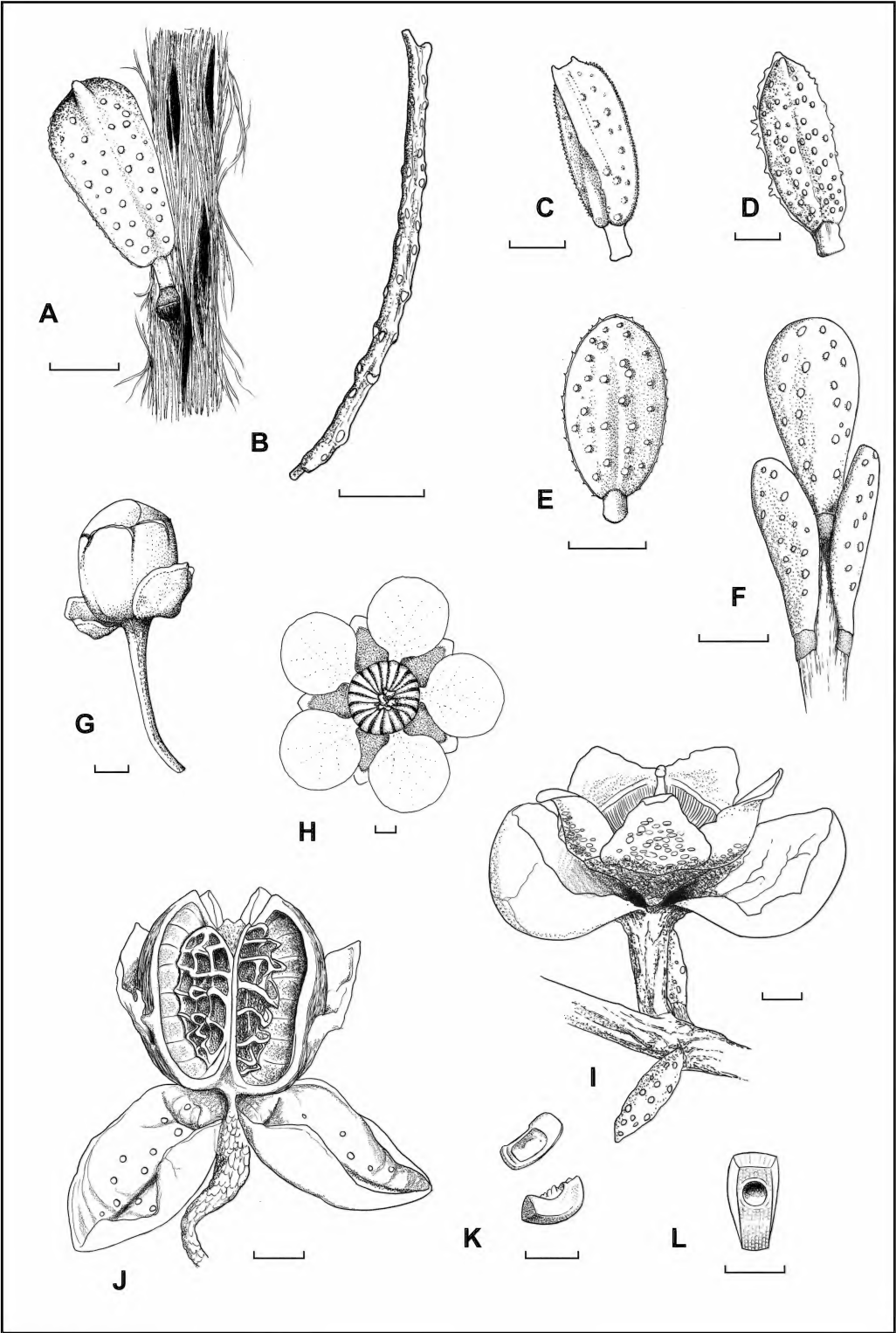


Figure 1. Caption overleaf.

Figure 1. Morphology in *Balaustion* sect. *Tilophloia*. A – young stem of *B. unguiculatum* with sub-epidermal tissue disintegrating into fibres and a leaf with an abrupt subterminal projection; B – leaf of *B. filifolium* from side view, showing terminal and subterminal points; C – leaf abaxial surface, showing a subterminal point of similar size to the apical point in *B. mukinbudin*; D – leaf abaxial surface in *B. polyandrum*, with subterminal point present but not very obvious from this viewpoint; E – leaf abaxial surface in *B. baiocalyx*; F – leaves of *B. karroun*, including one from side view showing the distally rounded keel; G – side view of flower bud in *B. baiocalyx* showing small bracteoles and very short sepals; H – top view of flower of *B. mukinbudin* showing numerous stamens and two-toned sepals; I – dehiscent fruit of *B. grandibracteatum* subsp. *grandibracteatum* showing a node with a pair of leaves, a peduncle, and two large, persistent bracteoles; J – fruit of *B. mukinbudin* cut open to show the large placentas and two large, persistent bracteoles; K – seeds of *B. mukinbudin* from side and inside view, showing a large cavity taking up much of the inner surface; L – seed of *B. thamnoides* showing a cavity much smaller than the inner surface. Scale bars = 1 mm. Drawn by Lisa Rye from K.R. Newbey 9195 (A), A.R. Main s.n. 11 Sep. 1957 (B), P. de Rebeira 15 (C, H), L.W. Sage & F. Hort 2229 (D); P. Armstrong s.n. 8 Sep. 1995 (E,G), H. Pringle 30157 (F), C.A. Gardner 8017 (I), M.E. Trudgen 5420 (J,K), and K.R. Newbey 6552 (L).

Anthers. The stamens are geniculate, bending abruptly to be angled in towards the centre of the flower shortly below the attachment to the thecae, but this character is less obvious in the type species, *B. pulcherrimum* because of its elongated thecae. In all species apart from *B. pulcherrimum*, the connective gland is obvious and more or less ovoid, with its broad end protruding slightly outside the attachment point of the filament and the smaller end broadly attached to the thecae. The gland varies from about twice as long as the thecae to only slightly longer than them and differs at least slightly in colour. From front view the anther is much broader than long. The thecae are quite small; they are connate and each opens across the end in a pore-like slit, with the pollen extruded as a mass that often stays on the anther in pressed specimens. The thecae are introrse and their terminal slits diverge at the base. In *B. pulcherrimum*, anthers appear to be fully erect as they have long, fairly erect, parallel thecae with longitudinal dehiscence and a shorter connective gland.

Gynoecium and fruit. There are 16–21 ovules per loculus in sect. *Balaustion*, mostly 5–9 per loculus in sect. *Nonfibrosa*, and 8–22 per loculus in sect. *Tilophloia*. The base of the style is enclosed in a cylindrical depression at the centre of the ovary and usually becomes more deeply inset in the fruiting stage as the fruit summit expands upwards. Fruiting placentas are sessile, with free margins extending outwards from a broad attachment. In sections *Balaustion* (Rye 2009a: Figure 1E) and *Tilophloia* (Figure 1J) they are ovate to broadly elliptic and particularly large, with seeds attached around the full perimeter. The attachment areas are contiguous and are demarcated by slight ridges to highly raised partitions. The adaxial surface has a light brown or grey, smooth, flat rim. Section *Nonfibrosa* differs from the other sections in having fewer seeds borne on more irregular fruiting placentas that are smaller than in the other two sections but still large enough to accommodate large attachment areas.

Seeds and chaff. Seeds develop from few to most of the ovules. They are 1.2–1.8 mm long in most species but 2.0–2.4 mm long in *B. pulcherrimum*, shallowly to deeply colliculate and shiny, with the colliculae usually not as deep on the outer surface as on the lateral ones. There is a large concavity on the inner surface, usually 0.5–1 mm long (Figure 1K), but only 0.3–0.4 mm long in *B. thamnoides* (Figure 1L). The chaff pieces usually vary greatly in size but are all distinctly smaller than the seeds and more obviously faceted. They are usually differently coloured, either paler or darker, than the seeds.

Key to the named genera and sections of subtribe *Hysterobaeckinae*

*Taxa that are keyed out more than once have an asterisk.

1. Seeds with a broad cavity usually 0.5–1 mm long on the inner surface, if the cavity smaller (0.3–0.4 mm in *B. thamnoides*) then with stem tissue disintegrating into numerous fibres **BALAUSTION**

2. Hypanthium petaloid, orange to deep red, 9–20 mm long, with sepals and petals the same colour. Anthers fairly erect, dehiscent by 2 long parallel slits. Style 20–24 mm long **BALAUSTION** sect. **BALAUSTION**
- 2: Hypanthium herbaceous, green to reddish, 1.5–4 mm long, with sepals and/or petals contrasting in colour. Anthers markedly tilted relative to filament, dehiscent by short divergent slits or pores. Style 2–12 mm long
3. Stems with sub-epidermal tissue that disintegrates into fibres. Stamen filaments \pm contiguous or with small gaps at base but not, or only a few of them, connate. Ovules usually 10–22 per loculus **BALAUSTION** sect. **TILOPHLOIA**
- 3: Stems with sub-epidermal tissue shed in strips with the epidermis. Stamen filaments either connate at the base or narrow and with distinct gaps between some or all adjacent filaments. Ovules usually 4–9 per loculus **BALAUSTION** sect. **NONFIBROSA**
- 1: Seeds lacking a cavity or with a cavity less than 0.3 mm long, or rarely with a narrow cavity less than 0.5 mm long. Stem tissue shed in strips or patches, with few or no fibres visible
4. Ovules 1 or 2 per loculus, if 2 then superposed **SCHOLTZIA**
- 4: Ovules 3–23 per loculus or rarely down to 2 per loculus in *Tetrapora*, if 2 then collateral, radially arranged if numerous
5. Ovary 1-locular or effectively so, i.e. with only one placenta
6. Stamen filaments very compressed at base. Anthers \pm compressed ovoid, the connective gland not or scarcely protruding **BABINGTONIA***
- 6: Stamen filaments moderately to very thick. Anthers very thick, either with a distinctly protruding, dorsal connective gland or almost globular **MALLEOSTEMON**
- 5: Ovary 2- or 3-locular and with the same number of placentas
7. Fruits indehiscent
8. Petals bright pink or orange to red. Stamens 30–60; connective gland not protruding. Fruits with a very hard, thick wall that is difficult to cut open **CHEYNIANA**
- 8: Petals white or pale pink. Stamens 15–20; connective gland obvious, protruding below the thecae. Fruits with moderately thickened walls, readily cut open **HYSTEROBAECKEA***
- 7: Fruits dehiscent at the summit by 2 or 3 valves
9. Stamens united **BABINGTONIA***
- 9: Stamens free
10. Anthers rather helmet-like in shape (often with lateral grooves) or 2-lobed, dehiscent by terminal pores, the connective gland not obvious or only shortly protruding
11. Peduncles 1–6-flowered. Flowers with petals 2.3–6.5 mm long (if petals more than 5 mm long then sepals 0.2–1.1

- mm long) and 8–25 stamens. Fruits 1/2 to largely inferior.
 Seeds brown **BABINGTONIA***
- 11:** Peduncles 1-flowered. Flowers with petals 4–7 mm long, sepals 1.1–1.6 mm long and 12–45 stamens. Fruits 1/2–2/3 superior. Seeds very dark brown or black **ANTICORYNE**
- 10:** Anthers of varied shape, either very compact (usually \pm globular) or with the connective gland obvious as a swelling connecting the thecae to the unmodified part of the filament (usually with the stamen having a distinct bend at the base of the connective)
- 12.** Anther connective gland either obscure or protruding by less than 0.25 mm from the base of the anther although it may be visible within the body of the anther, which is compact and often \pm globular
- 13.** Stamens (22–)25–35, in a continuous circle. Fruits 3-locular, fully inferior, with a broad, funnelled central depression **OXYMYRRHINE**
- 13:** Stamens 3–20(–25), in antisepalous groups (i.e. none directly opposite the centre of a petal) or if continuous then the fruits 2-locular. Fruits 2- or 3-locular, c. 1/2 to fully inferior, with a \pm cylindrical central depression
- 14.** Peduncles 1-flowered, with persistent bracteoles. Ovules 12–21 per loculus, never consistently 12. **ERICOMYRTUS**
- 14:** Peduncles 1–21-flowered, not regularly 1-flowered except in *Tetrapora tenuiramea*, with bracteoles usually shed before fruits form. Ovules 2–13 per loculus, never consistently 13
- 15.** Anthers broader than the height of each of the thecae; connective gland protruding beyond the thecae, becoming hollowed. Seeds distinctly faceted in most species **AUSTROBAECKEA**
- 15:** Anthers globular or longer than wide; connective gland often evident as a paler coloured patch on the upper surface of the anther but not protruding beyond the thecae, not becoming hollowed. Seeds unfaceted or scarcely faceted **TETRAPORA**
- 12:** Anther connective gland obvious as a swelling connecting the thecae to the unmodified part of the filament (usually with the stamen having a distinct bend at the base of the connective), the protruding part of connective gland at least 0.25 mm long
- 16.** Peduncles usually 3–9-flowered, never consistently 1-flowered (secondary axes absent). Seeds 0.6–0.8 mm long, reticulate-smooth. Occurring in eastern Australia and New Caledonia..... **SANNANTHA**
- 16:** Peduncles 1–4-flowered. Seeds 0.6–2 mm long, if less than 0.8 mm long then colliculate to tuberculate. Endemic to mainland Australia (if in eastern Australia and with multi-flowered peduncles then the lateral flowers with secondary axes)
- 17.** Seeds very smooth to almost tuberculate, without grooves. Extending from south-western and central Australia to north-western Victoria..... **HYSTEROBAECKEA***
- 17:** Seeds deeply colliculate or tuberculate, each swelling minutely grooved. Occurring in eastern Australia

18. Leaves linear to circular, not uncinat. Sepals with a dorsal horn
0.3–1.7 mm long..... **KARDOMIA**
- 18: Leaves linear or almost linear, uncinat. Sepals not horned..... **HARMOGIA**

Balaustion Hook., *Hooker's Icon. Pl.* 9, t. 852 (1851). *Type: Balaustion pulcherrimum* Hook.

Punicella Turcz., *Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Petersbourg* 10: 333 (1852). *Type: Punicella carinata* Turcz. = *Balaustion pulcherrimum* Hook.

Cheyenia J.Drumm. ex Harv., *J. Bot. Kew Gard. Misc.* 7: 56 (1855). *Type: Cheyenia pulchella* J.Drumm. ex Harv. = *Balaustion pulcherrimum* Hook.

Shrubs prostrate or up to 1.2(–1.7) m high, glabrous; flowering branchlets with 1 or 2 flowers or up to 6 pairs of flowers. *Young stems* leafy, with a loose, pale grey epidermis and sub-epidermal tissue that, in most species, disintegrates into fine fibres when shed. *Leaves* opposite and decussate or rarely in whorls of 3, usually with a short but well defined petiole; blade linear in outline to almost circular, up to about as thick as wide; abaxial surface deeply convex or with steep sides and a convex summit, with 1 or few main rows of oil glands on each side of midvein; adaxial surface flat, narrowly grooved along middle, with oil glands often not as conspicuous as on abaxial surface. *Peduncles* short to moderately long, 1-flowered. *Bracteoles* strictly opposite or subopposite, broad, with margins incurved. *Buds* very obtuse. *Pedicels* absent to long. *Hypanthium* very broad to bell-shaped or cylindrical, often rugose-pitted or dotted with oil glands; adnate part broadly obconic to depressed hemispherical, sometimes 5-lobed; free part erect or spreading. *Sepals* 5, persistent in fruit, shorter than petals, in many taxa with a pale margin. *Petals* 5, very shortly clawed, broadly obovate to transversely broadly elliptic, white to brightly coloured. *Antipetalous collectors* minute, pale. *Staminodes* rare or absent. *Stamens* 13–35, geniculate, fairly uniformly distributed in a circle, in most species contiguous or with small gaps at the base, erect to incurved, those directly opposite the petals longest and those opposite the centre of the sepals shortest. *Anthers* introrse. *Ovary* 3-locular, c. 1/2 to fully inferior; summit raised at centre of flower; placentas axile, large, sessile, the adaxial surface with a free smooth rim surrounding the large zone of attachment, with ovules attached around the full margin; ovules 4–22 per loculus. *Style* with the base inset in a cylindrical depression; stigma small to moderately large, peltate, circular from top view. *Fruits* dry, almost fully inferior to 2/3 superior, few- or many-seeded; valves 3, fairly thick, opening to an erect position, often somewhat rugose or glandular-colliculate; placentas usually very large, ovate to broadly elliptic. *Seeds* slightly to distinctly faceted, somewhat reniform, with a large rounded outer surface, two equal lateral surfaces and a large inner surface, 1.2–2.6 mm long; inner surface with a broadly concave, whitish cavity (0.3–)0.5–1 mm long; testa crustaceous, golden to dark brown or greyish, colliculate, somewhat shiny. *Chaffpieces* smaller than seeds and of a different colour.

Diagnostic features. Distinguished from other genera in subtribe Hysterobaeckeeinae by having a large cavity on the inner surface of its seeds. Other important characters: shrubs small, usually low-growing; sepals not horned; stamens 13–35, in a single circle; placentas sessile, large, with 4–22 ovules.

Size and distribution. A genus with 18 named species, endemic to the south-west of Western Australia, extending from Canna south-east to Frank Hann National Park and well inland. This distribution passes through parts of the Geraldton Sandplain, Avon Wheatbelt and Mallee bioregions of the South West Botanical Province and the Yalgoo and Coolgardie bioregions of the Eremaean Botanical Province, with one isolated record from the Murchison bioregion.

Etymology. ‘*Balaustion* is an old name given to the wild flowers of the Pomegranate’ (Hooker 1851).

Chromosome number. There is probably a uniform base chromosome number of $x = 11$ as in other genera of subtribe Hysterobaeckinae, but it is not known whether any polyploidy occurs in *Balaustion*. So far the only two records, both published by Rye (1979), are of the diploid number of $n = 11$, both from specimens now identified as *B. exsertum* (see details under that species).

Affinities. As discussed in the introduction, molecular studies suggest a relationship between *Balaustion* and the *Baeckea muricata* group as well as *Harmogia* and *Sannantha* from eastern Australian. Those related taxa do not have an obvious cavity on their seeds. However, two Western Australian species that do have a distinct, but narrow, cavity less than 0.5 mm long, are *Baeckea* spp. Nanga (A.S. George 11346) and Perenjori (J.W. Green 1516). In this case the seed is narrower on the inner surface and the cavity shape therefore also narrower than in *Balaustion* species. Those two species also differ in having some tendency for five antisepalous ribs on the hypanthium and base of the sepals, suggesting that they might be related to *B. elderiana* E.Pritz. and *Ericomyrtus* Turcz.

Co-occurring species. There has only been one record of co-occurrence of *Balaustion* species belonging to the same section. Two members of sect. *Tilophloia*, *B. thamnoides* (G.F. Craig 7029) and *B. grandibracteatum* subsp. *meridionale* Rye (G.F. Craig 7031), were recorded together near Mt Gibbs.

Balaustion pulcherrimum (sect. *Balaustion*) has been recorded growing with *B. quinquelobum* Rye (sect. *Tilophloia*) near Narembeen (B.L. Rye & M.E. Trudgen BLR 241153) and near Muntadgin (M.E. Trudgen MET 23383). It has also been recorded with *B. multicaule* (B.L. Rye & M.E. Trudgen BLR 241168) in the Sheoak Rock area, east of Hyden.

Baeckea muricata (sister to the *Balaustion* group) has been recorded growing with *Balaustion quinquelobum* at many locations from the Merredin area to east of Yellowdine (e.g. B.L. Rye & M.E. Trudgen BLR 241140) and with *B. grandibracteatum* at one locality (M.E. Trudgen MET 23363). Another member of the sister group, *Baeckea* sp. Chapman Road (M.E. Trudgen 5446), has been recorded (B.L. Rye & M.E. Trudgen BLR 241151) growing with both *Balaustion pulcherrimum* and *B. quinquelobum*.

Notes. Keighery (1982) suggested that bee-pollination is of greatest importance in *Baeckea* s. lat., with beetle- and fly-pollination of lesser importance. In comparison with other genera of Hysterobaeckinae, *Balaustion* has large flowers, which may produce more copious nectar. Such characteristics would be likely to predispose this group to specialisation for bird-pollination, as has occurred in *B. pulcherrimum*.

Key to species and subspecies of *Balaustion*

1. Petals orange or red, 7–10 mm long. Mature style 10–24 mm long
 2. Leaves keeled for full length of blade, with an apical point 0.15–0.3 mm long. Hypanthium 8–20 mm long. Mature style 20–24 mm long (Latham–Kirkalocka Stn–near Hyden–W of Kalgoorlie) **B. pulcherrimum**
 - 2: Leaves only keeled in distal half, often indented along the midvein proximally, lacking an apical point. Hypanthium 3–4 mm long. Mature style 11–12 mm long (Diemals Stn area) **B. tangerinum**
- 1: Petals white or pink, 2.5–7 mm long. Mature style 2–4 mm long

3. Young stems shedding outer layers in strips (without splitting into fibres). Stamens either all connate at the base, or in an interrupted circle with distinct gaps between some or all of the narrow-based filaments. Ovules 4–9(–11) per loculus
4. Peduncles 0–0.6 mm long, greatly exceeded by pedicels 2–8.5 mm long. Sepals 1.3–3 mm long. Stamens 16–28, basally united for 0.3–1 mm into a ring (Bookarra–Wongan Hills)..... **B. grande**
- 4: Peduncles 1–4.5 mm long, much longer than to slightly exceeded by pedicels 0–2 mm long. Sepals 0.5–1.3 mm long. Stamens 13–23, free, in an interrupted circle
5. Hypanthium ± hemispherical in bud and flower. Sepals 0.8–1.2 mm long. (Canna–Billeranga Hills) **B. hemisphaericum**
- 5: Hypanthium ± broadly obconic in bud and flower. Sepals 0.5–0.9 mm long. (Petrudor Rock Reserve–Wyalkatchem–Mukinbudin) **B. interruptum**
- 3: Young stems with outer layers tending to disintegrate into numerous fibres. Stamens all free or rarely with a few of the stamens connate, contiguous at base or with gaps narrower than the broad base of the filament. Ovules (8–)10–22 per loculus
6. Leaves all with the keel distally rounded, not knobbed or pointed (see Figure 1E & F), the apex also not pointed in most taxa
7. Mature stigma 0.3–0.4 mm diam. Seeds dark brown; cavity 0.3–0.4 mm long, much shorter than seed (Hatter Hill–Mt Gibbs area–near Frank Hann NP)..... **B. thamnoides**
- 7: Mature stigma 0.15–0.25(–0.3) mm diam. Seeds golden brown to medium brown; cavity 0.6–0.7 mm long, about half as long as seed
8. Leaves not much thickened, with the larger oil glands in 2 to 4 main rows on each side of midvein. Mature style 2.6–3.2 mm long. Occurring well to the N of Merredin
9. Sepals inconspicuous (see Figure 1G), 0.5–0.8 mm long. Bracteoles c. 2 mm long, shed early (near Kalannie–NE of Wongan Hills–E of Koorda)..... **B. baiocalyx**
- 9: Sepals obvious, 2–2.5 mm long. Bracteoles 4–6 mm long, persistent in flower (Diemals Stn–Bonnie Rock–Wialki)..... **B. karroun**
- 8: Leaves all or mostly very thick, less than four times as wide as thick, with the larger oil glands usually in 1 or 2 main rows on each side of midvein. Mature style 1.6–2.5 mm long. Occurring E and SE of Merredin
10. Shrub with multiple slender stems from a thickened woody base. Leaves 0.5–0.7 mm wide (S of Sheoak Rock)..... **B. multicaule**
- 10: Shrub single-stemmed or several-branched at base. Leaves 0.7–1.5 mm wide
11. Peduncles not changed much at distal end. Pedicels 0.7–1.5 mm long. Bracteoles usually caducous,

- 2–3 mm long (Mt Gibbs area–near NW end
Frank Hann NP) **B. grandibracteatum** subsp. **meridionale**
- 11: Peduncles usually broader and somewhat flattened distally. Pedicels 0–0.5(–0.7) mm long. Bracteoles caducous to persistent, 3–6 mm long
- 12: Bracteoles enclosing late buds and persistent after anthesis, usually present on mature fruits, 4–6 mm long (W of Southern Cross–Yellowdine) **B. grandibracteatum** subsp. **grandibracteatum**
- 12: Bracteoles enclosing young buds but rarely present at anthesis, absent from mature fruits, 3–5.5 mm long (Mt Holland area–Forrestania area) **B. grandibracteatum** subsp. **juncturum**
- 6: Young leaves with the keel projecting into a subterminal knob or small point, often with some leaves also with an apical point making them double-pointed (see Figure 1A–D).
- 13: Leaves obovate to almost circular, lacking a terminal point but with the keel often ending in an abrupt subterminal claw-like point. Associated with granite (N of Bullfinch) **B. unguiculatum**
- 13: Leaves linear in outline to obovate-elliptic, commonly double-pointed, both the keel and the apex tending to have a small point. Occurring on sandplain, with *B. spenceri* probably also associated with granite
- 14: Bracteoles enclosing the mature bud, often persistent after anthesis and embracing the hypanthium, 4–5.5 mm long. Pedicels ± absent. Sepals 1.4–2.5 mm long (Bonnie Rock–Chiddarcooping NR) **B. mukinbudin**
- 14: Bracteoles either borne well below the flowers at anthesis or shed at an earlier stage, 0.8–3.5 mm long. Pedicels 0.5–4 mm long. Sepals 0.8–2 mm long
- 15: Petals 6–7 mm long. Stamens c. 30. Ovules 20–22 per loculus (E of Koolyanobbing) **B. polyandrum**
- 15: Petals 3–6 mm long. Stamens 15–25. Ovules 8–16 per loculus
- 16: Mature style 1.4–2.2 mm long
- 17: Hypanthium with 5 lobes surrounding and extending slightly below (rarely level with) the apex of the pedicel (North Bungulla NR–Lake Grace–E of Lake King) **B. quinquelobum**
- 17: Hypanthium lacking lobes but sometimes with broadly rounded antisepalous ‘ridges’, entirely above the apex of the pedicel (Billyacatting Hill area) **B. sp. Billyacatting Hill**
- 16: Mature style 2.5–4 mm long
- 18: Petioles 0.1–0.2 mm long. Longest leaf blades 3–7 mm long, 0.2–0.3(–0.4) mm wide, broadest at the base, entire (Bonnie Rock area–Mukinbudin area) **B. filifolium**

- 18:** Petioles 0.2–0.6 mm long. Longest leaf blades 1.3–5 mm long, 0.3–1.2 mm wide, usually narrowed at the base or not exceeding the width elsewhere, toothed laterally or around the apex at least when young
- 19:** Bracteoles 2–3.5 mm long. Pedicels 0.6–2 mm long, much shorter than the peduncles (S of Mukinbudin) **B. bimucronatum**
- 19:** Bracteoles 0.8–1.6(–2) mm long. Pedicels (1.2–)2–3.5 mm long, shorter than to much longer than the peduncles
- 20:** Leaf blades not very thick, remaining flattened at all stages (W of Bullfinch)..... **B. spenceri**
- 20:** Leaf blades 0.4–0.5 mm thick, mostly or at least some of them not much broader than thick (Waddouring Hill–Hyden area) **B. exsertum**

A. *Balaustion* Hook. sect. *Balaustion*

Shrubs prostrate, often with adventitious roots; flowering branchlets with 1 or 2(–6) fertile nodes, the flowering nodes often separated by sterile nodes. *Young stems* with sub-epidermal tissue that disintegrates into fine fibres. *Leaves* with petiole very well defined; blade dorsiventrally flattened, with an apical point. *Peduncles* longer than pedicels, which are usually \pm absent. *Bracteoles* not scarious except on the margin. *Flowers* uniformly orange or red on the hypanthium, sepals and petals. *Hypanthium* long, bell-shaped or more cylindrical, free from ovary for more than half of its length. *Sepals* lacking an obviously contrasting border (fairly uniformly coloured). *Petals* erect or somewhat spreading, laciniate-toothed. *Stamens* 15–35, free, contiguous, without an obvious bend. *Broadest filaments* 0.4–0.7 mm wide near base. *Anthers* appearing \pm erect and \pm basifixed, dehiscent by long parallel slits; connective conspicuously coloured but gland not very obvious; thecae erect, parallel, longer than the connective. *Ovary* inferior; ovules 16–21 per loculus. *Fruits* almost fully inferior and hidden within the base of a long hypanthium, which has the same texture throughout. *Seeds* 2.4–2.6 mm long, medium brown, sometimes somewhat greyish, deeply colliculate.

Diagnostic features. Distinguished from the other two sections by its longer hypanthium, rather erect anthers dehiscent by long parallel slits, longer style and larger seeds.

Size and distribution. A monotypic section occurring in the Avon Wheatbelt and Mallee Bioregions of the South West Botanical Province and the Murchison, Yalgoo and Coolgardie bioregions of the Eremaean Botanical Province (Figure 3).

Notes. This section was revised in Rye (2009a) as *Balaustion s. str.* It comprises the only species of the now greatly expanded genus to have the hypanthium, sepals and petals all of the same colour, a character presumably adaptive to bird pollination. The sepals lack the obviously contrasting border found commonly in members of the other two sections of *Balaustion* although the border is thinner in texture and may differ somewhat in its colouring from the remainder of the outer surface.

1. *Balaustion pulcherrimum* Hook., *Hooker's Icon. Pl.* 9: t. 852 (1851). *Type citation:* ‘South-western Australia, discovered between the Swan River and King George’s Sound, *Drummond*’. *Type:* S.W. Australia, 1850 [south-west of Western Australia, 1847–1849], *J. Drummond* coll. 5 suppl.: 26 (*lecto*, here designated (or possible *holo*): K 000355362; *isolecto*: BM 000793705, G 00227446, K 000355360 & 000355361, KW photo seen).

Punicella carinata Turcz., *Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Petersbourg* 10: 333 (1852). Type: 'Drum. V, n. 26' [south-west of Western Australia, 1847–1849], *J. Drummond* coll. 5 suppl.: 26 (*holo*: KW photo seen; *iso*: BM 000793705, G 00227446, K 000355360–000355362).

Cheynia pulchella J.Drumm. ex Harv., *J. Bot. Kew Gard. Misc.* 7: 56 (1855). Type: 'Northern districts' [south-west of Western Australia], *J. Drummond s.n.* (*holo*: TCD *n.v.*).

Illustrations. W.J. Hooker, *Hooker's Icon. Pl.* 9: t. 852 (1851); W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildfl.* 3A: 88 (1980); M.G. Corrick, B.A. Fuhrer & A.S. George, *Wildfl. Southern W. Austral.* (1996: Figure 328); B.L. Rye, *Nuytsia* 19: 133, Figure 1 (2008); drawing on C.A. Gardner *s.n.* 20 Sep. 1934 (PERTH 03479382).

Prostrate *shrub* 0.2–1.2 m across, sometimes with centre raised up to 0.2 m high; flowering branchlets with 1 or 2 or rarely up to 6 fertile nodes each bearing 1 or 2 flowers. *Leaves* mostly antrorse to patent. *Petioles* 0.3–0.6 mm long. *Leaf blades* ovate to narrowly obovate, 2.7–6 mm long, 1.2–1.5 mm wide, often glossy, margins laciniate or entire, with a white apical point 0.15–0.3 mm long; abaxial surface with a narrow keel that is prominent especially towards the apex, the larger oil glands in 2–4 main rows on each side of midvein. *Peduncles* 2–4 mm long, often orange to deep maroon. *Bracteoles* persistent, 2–3.5 mm long, orange with a somewhat greenish base or orange throughout to reddish. *Pedicels* up to c. 1 mm long but usually absent. *Flowers* 15–25 mm diam., orange or red on the hypanthium, sepals and petals. *Hypanthium* bell-shaped or more cylindrical, 8–20 mm long, 6–8 mm diam. at summit; free part 5–14 mm long. *Sepals* very broadly or depressed ovate, 2.5–4 mm long, 3–6.5 mm wide, entire to minutely lacinate. *Petals* erect or somewhat spreading, 7–9 mm long. *Stamens* as described for the section. *Antipetalous filaments* 6.5–8(–11) mm long. *Anthers* 0.4–0.6 mm wide, almost basifixed, introrse; connective broad and protruding to inside of thecae, 0.35–0.6 mm long, orange or reddish; thecae fairly erect, parallel, 0.55–0.9 mm long, pale-coloured. *Ovary* inferior; ovules 16–21 per loculus. *Style* 20–24 mm long; stigma 0.4–0.8 mm diam. *Fruits* 7–8 mm long, 9–10 mm diam., the hypanthium usually 10–15 mm long; placentas broadly ovate, 3–4.5 × 2.5–3.5 mm. *Seeds* somewhat faceted, 2.4–2.6 mm long, 0.7–1 mm wide, 1.4–1.6 mm thick; inner cavity 0.5–0.7 mm long. (Figure 2)

Diagnostic features. As for the section.

Selected specimens examined. WESTERN AUSTRALIA: on E side of main N–S track c. 7.7 km SSE Corriding Rock, ex Credo Station, 5 Sep. 2011, *N. Gibson & M.A. Langley* 5244 (PERTH); Mt Gibson Wildlife Sanctuary, Emu track, c. 6.1 km E of Goodlands Rd, 7 Oct. 2015, *M. Hislop & F. Lewis* MH 4540 (PERTH); Scott Rd, 5.3 km SSE of Bulls Head Rd, 1.9 km W of Koonadgin Rd, SE of Merredin, 4 Nov. 2004, *B.L. Rye & M.E. Trudgen* BLR 241135 (PERTH); Lazy Dee Farm, 27 km E of Hyden on Hyden–Norseman Rd, 22 June 2016, *J.E. Wajon* 3568 (PERTH).

Distribution and habitat. Extends from near Mongers Lake (east of Perenjori) and Kirkalocka Station south-east to near Hyden (Figure 3), occurring with varied sandplain species, often in yellow sand.

Phenology. Flowers recorded mainly from September to November and mature fruits mainly from October to December.

Etymology. From the Latin superlative of *pulcher* (beautiful), i.e. very beautiful or most beautiful.

Vernacular name. Native Pomegranate.

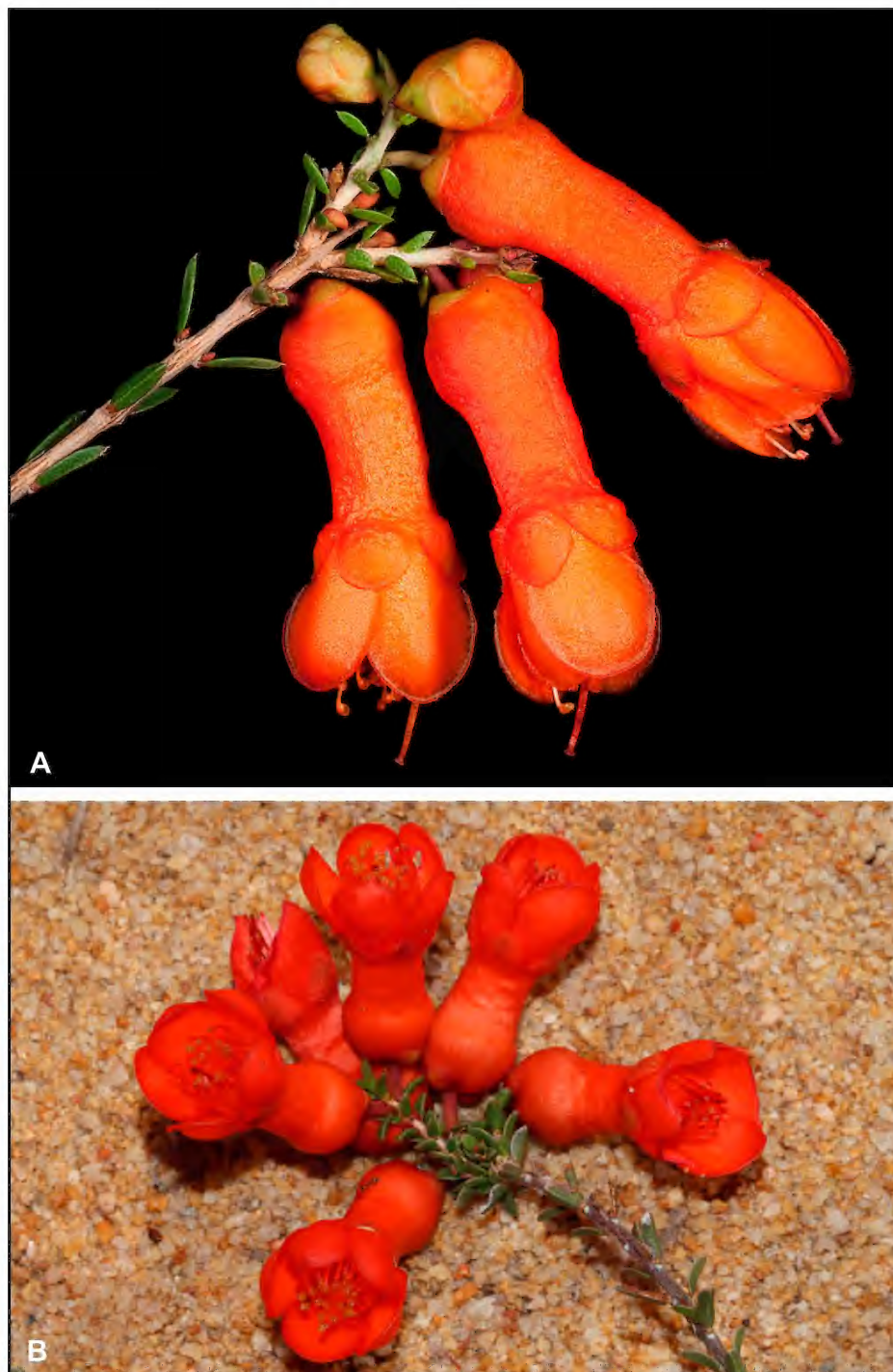


Figure 2. *Balaustion pulcherrimum*. A – a picked flowering stem showing the young stem starting to disintegrate into fibres, two flower buds and three open flowers with a protruding style; B – a prostrate flowering stem on sand at a reserve west of Lake Koorkoordine, showing flowers from top view. Photographs by Kevin Thiele (A, from K.R. Thiele 4253) and Juliet Wege (B, unvouchered).

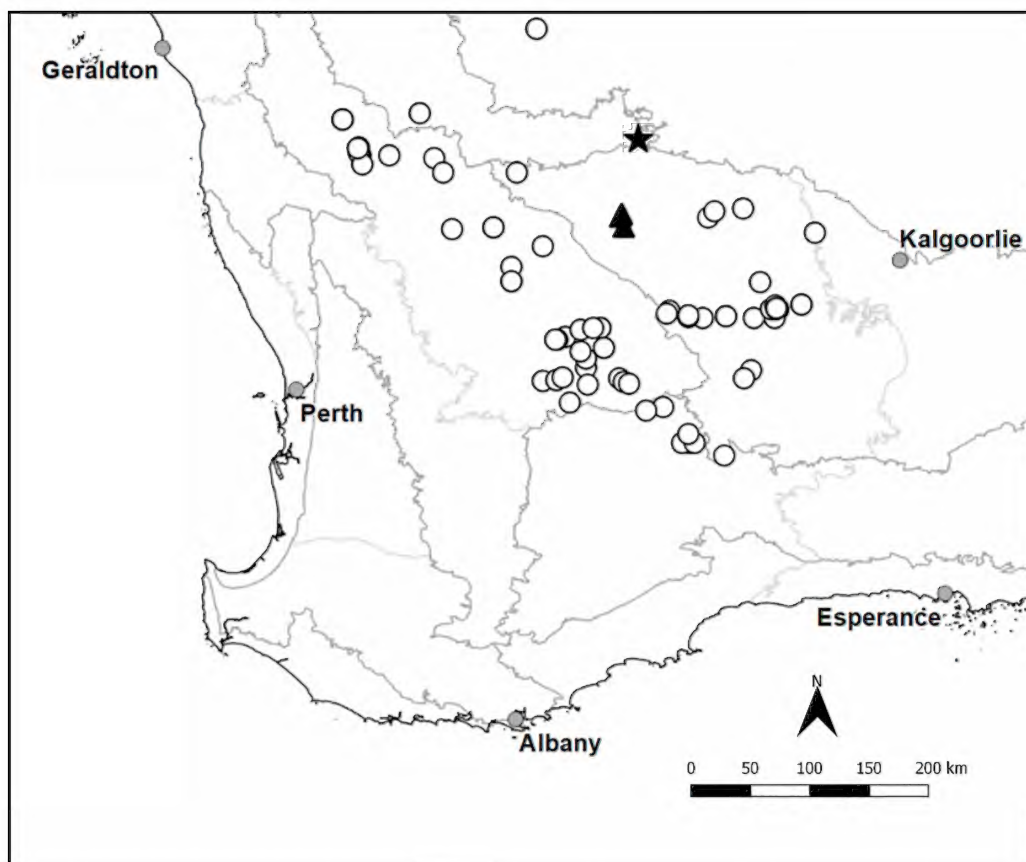


Figure 3. Distribution of the monotypic *Balaustion* sect. *Balaustion*, i.e. of *B. pulcherrimum* (O), the possible hybrid *B. tangerinum* (★) and possible parent *B. unguiculatum* (▲).

Conservation status. A widespread species that is not considered to be at risk.

Typification. The KW holotype of *Punicella carinata* Turcz. has not been examined and is not currently displayed on *Global Plants*. However, a photograph of it taken by Neville Marchant has been seen at PERTH. A specimen examined by Hooker, K 000355362, is likely to be the holotype of *Balaustion pulcherrimum* Hook. because it is the only specimen stamped 'Herb. Hookerianum'. To avoid any doubt, this specimen is designated here as the lectotype.

Notes. At least one specimen (*W.E. Blackall s.n.* Sep. 1929) has the leaves in whorls of three, but the flowers are still only one or two per node.

Balaustion pulcherrimum has the largest area of distribution in the genus and its range overlaps the area of occurrence of some members of sect. *Tilophloia* (see co-occurring species section above). There is a possibility that *B. tangerinum* (see discussion under that taxon) is a hybrid between sections *Balaustion* and *Tilophloia*.

B. Balaustion sect. **Nonfibrosa** Rye, *sect. nov.*

Type: Balaustion grande (E.Pritz.) Rye.

Shrubs low or rarely over 1 m high; flowering branchlets with 1–6 fertile nodes, each node usually with a pair of flowers. *Young stems* with outer layers shed in long narrow strips but without disintegrating into fine fibres. *Leaves* \pm sessile or with a very short petiole that is not as well defined as in the other sections; blade thick, not pointed. *Peduncles* very short to greatly exceeding the pedicels. *Bracteoles* scarious or partially herbaceous. *Flowers* with hypanthium and sepals distinct in their colouring from the petals. *Hypanthium* broadly obconic to hemispherical, adnate to ovary for most of its length. *Sepals* somewhat herbaceous with a petaloid border. *Petals* widely spreading or fairly erect, white or pink, minutely denticulate or entire. *Stamens* 13–27, either connate at the base or separated by distinct gaps, with a subterminal, 90° bend. *Broadest filaments* (at lowest free point) 0.1–0.5 mm wide. *Anthers* attached almost at base of connective gland to the free filament, dehiscent by two elliptic pores or short slits that diverge at the base; connective gland conspicuous, the exposed part somewhat longer than the thecae. *Ovary* c. 2/3 inferior to just over 1/2 superior; placentas \pm elliptic, not particularly large; ovules 4–9(–11) per loculus. *Fruits* c. 1/2–2/3 superior, with hypanthium much shorter than the fruit. *Seeds* 1.3–1.6 mm long, pale to medium brown, deeply colliculate.

Diagnostic features. Distinguished from the other two sections of *Balaustion* by having the stamens either connate at the base or separated by distinct gaps, young stems shedding outer layers in strips rather than fibres, leaves sessile or less obviously petiolate, usually fewer ovules, and smaller fruiting placentas.

Size and distribution. Three species are recognised, occurring in the Avon Wheatbelt and Geraldton Sandplains bioregions of the South West Botanical Province and the Yalgoo bioregion of the Eremaean Botanical Province. The section extends from Canna south-east to Wyalkatchem (Figure 4).

Etymology. From the Latin *non* (not) and *fibrosus* (fibrous) as the outer stem tissue does not disintegrate into numerous fibres.

Notes. The few species placed here fall into two distinct categories based on their peduncle lengths and stamen characters (see key) but are placed in the same section because of their non-fibrous young stems and some similarities in their habit, leaf morphology, placentas, ovule numbers, seed surface and geographic distribution. They have a rugose-pitted hypanthium and persistent bracteoles like those of the *B. exsertum* group. Their seeds are deeply colliculate (almost tuberculate) whereas those of sect. *Tilophloia* are shallowly colliculate. Their petals are about 2–3 times longer than the stamen filaments whereas sect. *Balaustion* has petals and stamens of about the same length.

2. Balaustion grande (E.Pritz.) Rye, *comb. nov.*

Baeckea grandis E.Pritz. in L. Diels & E. Pritzel, *Bot. Jahrb. Syst.* 35: 417 (1904). *Type citation*: ‘Hab. in distr. Irwin haud proc. a Greenough River pr. Bukara in fruticosis glareoso-arenosis flor. m. Sept. (D. 6028)’. *Type specimens*: Bukara [Bookara], south of Greenough River, Western Australia, 10 September 1901, *F.L.E. Diels* 6028 (*lecto*, here selected: PERTH 01605569 ex B; probable *isolecto*: PERTH 03353893 ex B).

Baeckea grandis var. *brevifolia* C.A.Gardner ms, *in sched.* (PERTH 03353834, PERTH 03353842).

Baeckea grandis var. *minor* W.E. Blackall *nom. nud.*, in W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildfl.* 1: 289 (1954); *in sched.* (PERTH 03353761, PERTH 08511861).

Illustrations: W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildfl.* 1: 289 (1954), as *Baeckea grandis*; drawings on C.A. Gardner 2701 (PERTH 03353834) and F. Vanzetti s.n. (PERTH 03353842).

Low-growing *shrub*, usually 0.4–0.5 m high, 0.2–1 m wide; flowering branchlets with 1–3(–6) pairs of flowers. *Leaves* mostly antrorse to patent, often clustered. *Petioles* 0–0.3 mm long. *Leaf blades* \pm oblong or narrowly oblong in outline, 2–4(–6) mm long, 0.5–1 mm wide, 0.4–0.8 mm thick, obtuse, initially with scarious lateral margins up to 0.3 mm wide that are broadest towards the apex and sometimes denticulate, tending to lose the scarious borders and become consistently entire at maturity; abaxial surface deeply curved on each side of the convex centre to form almost parallel sides, the oil glands in 1–4 main rows on each side of midvein, of very variable number but often *c.* 6 per row; adaxial surface fairly flat. *Peduncles* 0–0.6 mm long. *Bracteoles* persistent, 1.5–2.3(–2.5) mm long. *Pedicels* (2–)6–8.5 mm long. *Flowers* 8–13 mm diam. *Hypanthium* 1–1.5 mm long, 1.75–3.5 mm diam., finely rugose-pitted; free part 0.4–0.8 mm wide. *Sepals* broadly to depressed ovate, 1.3–3 mm long, 2.3–3.5 mm wide, deep maroon except near margin, the midvein often raised (but not part of any definite ridge); whitish border 0.2–0.6 wide, entire. *Petals* 2.5–6 mm long, usually white or pale pink, rarely a more obvious pink. *Stamens* 16–28, connate in a ring. *Antipetalous filaments* 1.2–2.5 mm long, united in basal 0.3–1 mm, up to 0.5 mm broad at base. *Anthers* *c.* 0.3 mm wide from front view;

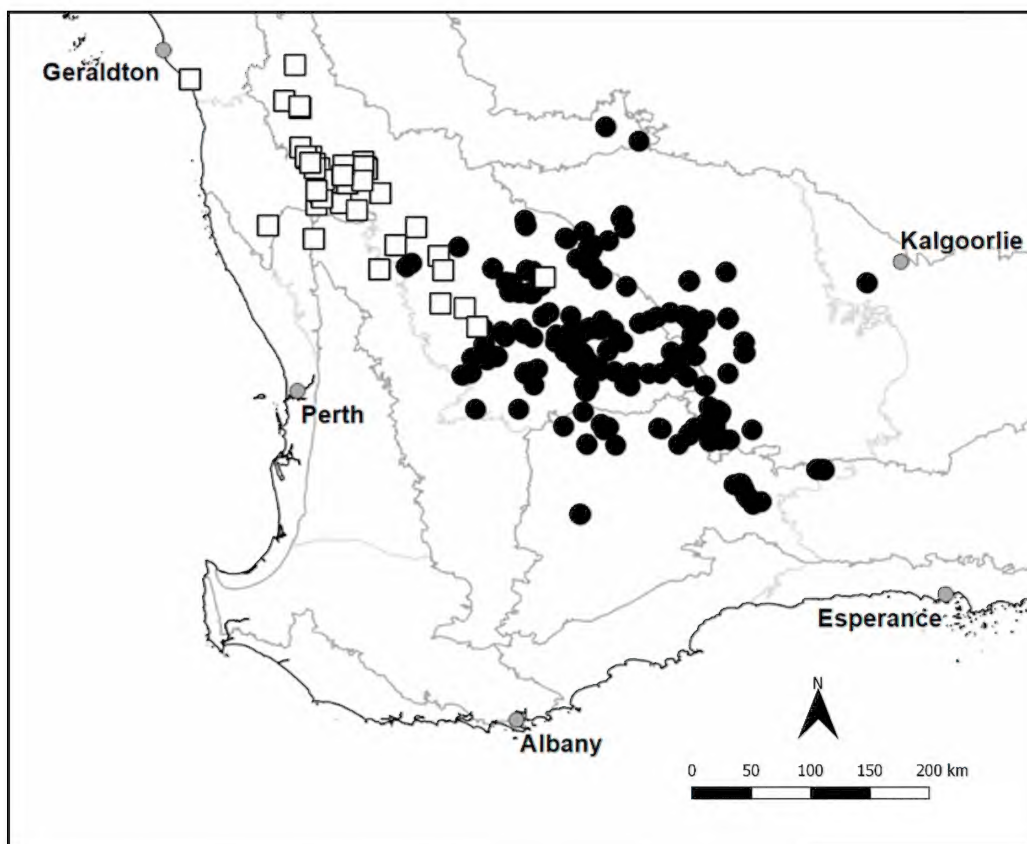


Figure 4. Distribution of *Balaustion* sections *Nonfibrosa* (□) and *Tilophloia* (●).

connective gland 0.3–0.35 mm long, pale-coloured; thecae 0.15–0.2 mm long, deep maroon. *Ovary* c. 1/2 or just over 1/2 superior; ovules 4–9 per loculus. *Style* 1.5–2.5 mm long; stigma 0.2–0.3 mm diam. *Fruits* c. 2/3 superior, 2.5–3.5 mm diam., 2–3 mm wide; hypanthium very shallow, smooth; placentas often irregular in height, \pm elliptic to almost oblong in outline, $1\text{--}1.4 \times 0.55\text{--}0.65$ mm. *Seeds* 1.2–1.6 mm long, 0.5–0.7 mm wide, 0.65–0.75 mm thick, pale to medium brown, deeply colliculate; inner cavity 0.5–0.8 mm long.

Diagnostic features. Distinguished from all other members of the genus by its basally connate stamens and by its pedicels, which usually greatly exceed the peduncles in length.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 18 Sep. 2008, *R.L. Barrett, M.D. Barrett & C. Karsten* RLB 5072 (NSW, PERTH); Aug. 1977, *C. Chapman s.n.* (AD, BRI, NSW, PERTH); 15 Oct. 1982, *J. Coleby-Williams* 226 (PERTH); 4 Oct. 1981, *L.A. Craven* 6925 & *C. Chapman* (CANB n.v., MEL n.v., PERTH); 2 Sep. 2008, *M. Davis* 508 (PERTH); 20 Sep. 1985, *N. Hoyle* 307 (CANB, PERTH); 20 Sep. 1981, *B. Jack & V. Syme s.n.* (PERTH); 18 Sep. 2002, *M.E. Trudgen* 21607 (CANB, K, MEL, PERTH); 8 Nov. 2009, *M.E. Trudgen & P. Jobson* MET 23596 (PERTH); 31 Aug. 1976, *L.D. Williams* 8586 (AD n.v., PERTH).

Distribution and habitat. Commonly occurs on sandplains or in sand overlying laterite. The full range recorded for this species is from Bookara (south of Greenough River) south-east to Wongan Hills (Figure 5). However, all collections since 1975, and also most of the collections up to 1975, have come from the region bounded by Winchester, Moora and Wubin. This main area of occurrence for the species was described by Griffin (1994 Appendix 6, p. 20) as east of the Darling fault. Four outlying localities that might not all be reliable are shown with an open symbol in the distribution map (Figure 4), as follows:

1. the type locality of ‘Bukara’ is 130 km north-east of the confirmed range of *B. grande* based on subsequent collections. The collecting routes taken by Diels (see Diels & Pritzel 1904) did also include many locations that are well within the confirmed range, such as Watheroo, so there is a possibility that the type locality was incorrectly recorded. However, if the date given for the type collection of 10 September 1901 is correct, then the locality must have been much closer to Bookara and the species must be assumed to have a large disjunction in its range.
2. ‘near Mullewa (south of)’ on *M.E. Trudgen s.n.* 1975 (PERTH 03353648). This vague locality could be taken to include the confirmed range of *B. grande*, which begins c. 130 km south of Mullewa; however, the implication is that it came from much closer to Mullewa, so it has been mapped as Mullewa in Figure 3B. The locality of this unnumbered collection, with no precise date and without any habitat information, is likely to be inaccurate or extremely vague.
3. ‘Hill River’ on *N.H. Speck s.n.* 22 Sep. 1951 (PERTH 03353591). This vague locality has been mapped as the upper reaches of Hill River, but the entire river is on the west side of the Darling fault.
4. ‘Wongan Hills’ on *C.A. Gardner s.n.* Dec. 1924 (PERTH 03353788). Both the locality and late flowering time of December are doubtful for this specimen, but perhaps the main reason for concern is that this sheet previously also had a piece of *Tetrapora floribunda* (Benth.) Trudgen & Rye, which has now been removed to a separate sheet (PERTH 08254192). *Tetrapora floribunda* is typical of the Wongan Hills flora and known to include a flowering time of December so the presence of *B. grande* may have been an accidental admixture of a quite independent collection.

Phenology. Flowers recorded from July to October and mature fruits from September to November.

Etymology. From the Latin *grandis* (great, large), presumably referring to the large size of the flowers in comparison with most other species that have been included within *Baeckea* s. lat. According to the protologue, the sepals are about 4 mm long and the petals are up to 7–9 mm long or wide, although the few flowers on the PERTH type specimens have sepals 2–2.5 mm long and petals 5–6 mm long.

Conservation status. This species has a good number of specimens, including two from a nature reserve, but there are few recent collections. Recently listed as Priority Three under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998 –), as *Baeckea grandis*.

Typification. Two fragments of Diels' gathering of *Baeckea grandis* were obtained by Charles Gardner from Berlin prior to the destruction of Myrtaceae type material housed at B during WWII; no other duplicates of this collection are known. The designated lectotype (PERTH 01605569), which has the locality 'Bukara', is a very small piece but has a number of open flowers attached as well as a packet containing a dissected flower. The fragment on the other specimen (PERTH 03353893) is larger and mostly in bud with only one open flower and, although annotated by Gardner as *B. grandis*, is incorrectly labelled as 'in distr. Irwin pr. Greenough River, pontem Mullewensem in fruticetis arenosis, L. Diels 4192 Septem. 1901', details that match the type citation of *Baeckea staminosa* E.Pritz. This specimen, which has connate stamens, is referable to *B. grandis* and is interpreted here as probable type material.

Variation. According to the protologue, the type has leaves 2–3 mm long, and measurements of the type fragments confirm this. Specimens that have been identified as *Baeckea grandis* var. *brevifolia* C.A.Gardner ms (*C.A. Gardner* 2701 and *F. Vanzetti* s.n. Oct. 1928) have leaves of a similar length, i.e. should be considered the typical variant in this respect, although in the former case only one of the four pieces mounted has consistently short leaves. Most other specimens have predominantly long leaves, with the maximum length recorded being c. 6 mm, or a mixture of short and long leaves, rendering this leaf character unsuitable for distinguishing entities within the species.

There is considerable variation in flower size in the species. Blackall and Grieve (1954: 289) recognised two entities, with *Baeckea grandis* keyed as having large flowers with petals '± 4 mm diam.' and *B. grandis* var. *minor* Blackall nom. nud. as having small flowers with petals '± 2 mm diam.'. In fact, the smallest-flowered specimens at PERTH (e.g. *M. Davis* 508 and *F. Lullfitz* L1892) have petals c. 2.5 mm long and c. 3 mm diam., and so fall halfway between the two choices of petal diameter offered in Blackall and Grieve's key. Diels and Pritzel (1904: 417) recorded the petals as 'ad 7–9 mm longa ac. lata' but the maximum size recorded in the current study was 6 mm long.

Most specimens have white or pale pink petals but a few collections (*L.A. Craven* & *C. Chapman* 6925, *C. Chapman* s.n. Aug. 1977) appear to have bright pink flowers. Pedicel length varies from about 2 mm to 8.5 mm. Stamen numbers and the degree to which stamens are united also show considerable variation within *B. grande*.

Affinities. This species is presumed to be more closely related to *B. hemisphaericum* and *B. interruptum* than to all other members of the genus (see notes under section description), although these taxa are readily distinguished by their longer peduncles and free stamens. They also differ in having shorter sepals, more truncate leaves, the hypanthium adnate to the ovary for a greater proportion of its length, and the style usually 0.7–1 mm longer than the stamen filaments (*B. grande* generally has little or no difference in the lengths of these organs).

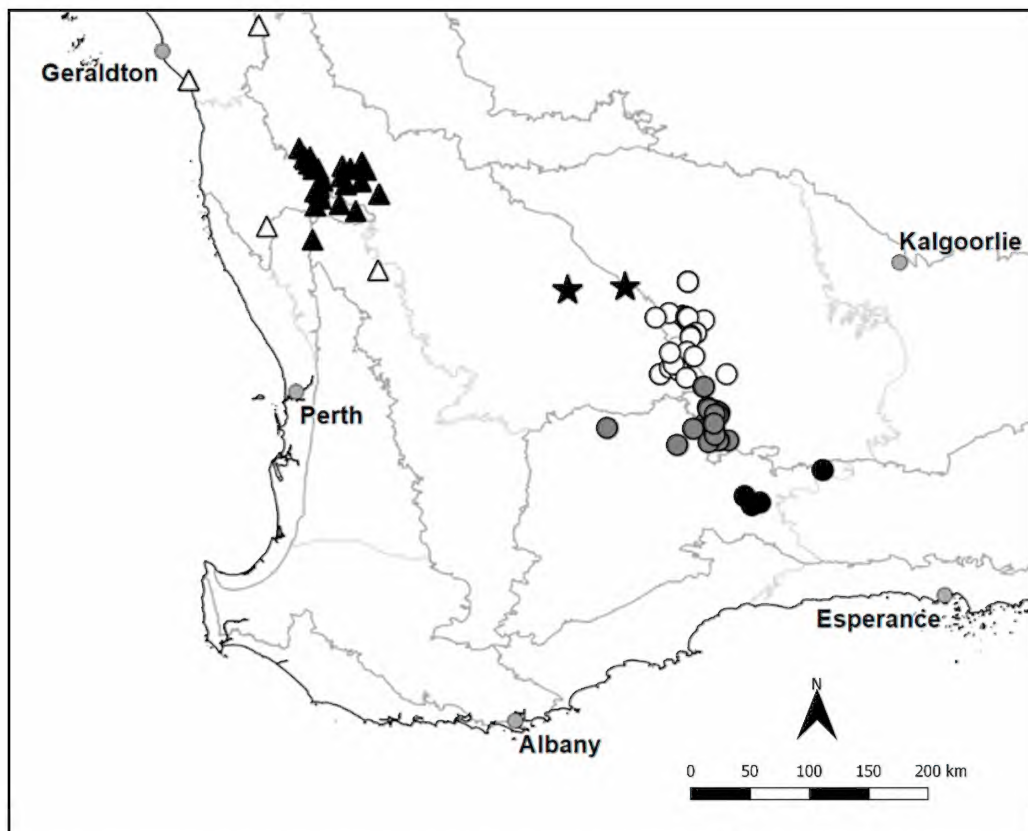


Figure 5. Distribution of *Balaustion bimucronatum* (★), *B. grande* confirmed (▲) and unconfirmed localities (△), *B. grandibracteatum* subsp. *grandibracteatum* (○), *B. grandibracteatum* subsp. *juncturum* (◐) and *B. grandibracteatum* subsp. *meridionale* (●).

Notes. Although several characters described above are sufficiently variable to have prompted the recognition of additional entities, no clear discontinuities in morphology have been found to justify recognising more than one species or subspecies. Field work targeting *B. grande* populations is needed to clarify the variation further and could possibly lead to the description of additional taxa.

3. *Balaustion hemisphaericum* Rye, *sp. nov.*

Type: north-east of Arrino, Western Australia [precise locality withheld for conservation reasons], 25 September 1990, R.J. Cranfield & P.J. Spencer 7853A (*holo:* PERTH 01209345; *iso:* CANB, K, MEL, NSW).

Baeckea cryptonoma Trudgen ms, in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 347 (2000), *ex parte*; Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022], *ex parte*.

Shrub 0.2–0.6(–1) m high, c. 0.5 m wide; flowering branchlets with 1–6 pairs of flowers. *Leaves* antrorse to patent. *Petioles* 0–0.15 mm long. *Leaf blades* ± oblong to narrowly oblong-obovate in

outline, 1.4–1.7(–2.5) mm long, 0.7–1 mm wide, 0.6–0.8 mm thick, \pm truncate, denticulate (at least distally) on a narrow scarious margin; abaxial surface deeply convex (with almost parallel sides), oil glands in 2 or 3 main rows on each side of midvein, few per row; adaxial surface fairly flat. *Peduncles* 2–4.5 mm long. *Bracteoles* \pm opposite to *c.* 1 mm separated, persistent, ovate or broadly ovate, 1.3–1.5 mm long. *Pedicels* (0–)0.4–2 mm long. *Flowers* 7.5–9 mm diam. *Hypanthium* hemispherical, 1.3–1.5 mm long, 2.5–3.5 mm diam., very pitted-rugose on adnate part; free part 0.3–0.5 mm long. *Sepals* depressed ovate, 0.8–1.2 mm long, 1.5–2.2 mm wide, herbaceous base thickened and pitted-rugose but usually not obviously ridged; petaloid border 0.35–0.5 wide, largely deep pink, with a white edge, entire. *Petals* 2.5–4 mm long, usually 3–4 mm wide, white or pink, minutely denticulate on the margin. *Stamens* 16–23, free, widely spaced. *Antipetalous filaments* 1.1–1.5 mm long, up to *c.* 0.25 mm wide at the base. *Anthers* *c.* 0.3 mm wide from front view; connective gland 0.3–0.4 mm long, often appearing brownish to deep maroon on dried material; thecae 0.2–0.3 mm long, maroon. *Ovary* *c.* 2/3 inferior; ovules usually 5–8. *Style* 1.8–2.4 mm long; stigma 0.15–0.2 mm diam. *Fruits* 1/2–2/3 superior, 2–2.7 mm long, 2.5–3 mm diam.; placentas much raised at centre, ovate to circular in outline, 0.7–1.1 \times 0.5–0.65 mm. *Seeds* 1.3–1.5 mm long, 0.65–0.7 mm wide, 0.65–0.7 mm thick, medium brown, deeply colliculate; inner cavity 0.7–1 mm long.

Diagnostic features. Distinguished by the following combination of characters: hypanthium hemispherical, 1.3–1.5 mm long; sepals 0.8–1.2 mm long; stamens 16–23, widely spaced.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 1 Nov. 1974, *J.S. Beard* 7247 (PERTH); 10 Oct. 2006, *J. Borger* CM 1010–6 (AD, PERTH); 15 July 2008, *A. Chant* 649 (PERTH); 25 Sep. 1990, *R.J. Cranfield & P.J. Spencer* 7853 (PERTH); 19 Aug. 2019, *M. Hislop* 4793 (PERTH); 18 Aug. 1997, *F. Keast* M5A 210 (PERTH); 15 Aug. 1990, *G.J. Keighery & J.J. Alford* 2049 (BRI, PERTH); 3 Oct. 1994, *S. Patrick* 2021 (PERTH).

Distribution and habitat. Extends from Canna south-east to Billeranga Hills (Figure 6), often occurring on rocky or gravelly habitats with *Allocasuarina* and/or *Melaleuca* species dominant.

Phenology. Flowers from July to early October, with mature fruits recorded from October to November.

Etymology. From the Greek *hemi-* (half-) and *sphaericus* (spherical), referring to the shape of the hypanthium in bud and flower.

Conservation status. To be listed as Priority One under Conservation Codes for Western Australian Flora (Tanya Llorens pers. comm.). This newly recognised species is very restricted.

Affinities. *Balaustion hemisphaericum* was previously considered to be just a variant of *B. interruptum* but has a more northern distribution and is distinguished by its more or less hemispherical hypanthium and longer sepals, with the hypanthium and sepals tending to have a more encrusted, pitted and less obviously ridged appearance. *Balaustion interruptum* tends to have entire leaves or to have less obviously denticulate leaves than *B. hemisphaericum* and a larger stigma. It also tends to have fewer stamens, with 13–20 per flower; *B. hemisphaericum* usually has 17–23 stamens but a minimum of 16 stamens has been recorded in a specimen from Canna (*G.J. Keighery & J.J. Alford* 2049).

Notes. Although a minimum leaf length of 1.4 mm is recorded in the species description above, some specimens have very few leaves as large as this, with the great majority of their leaves about 1 mm

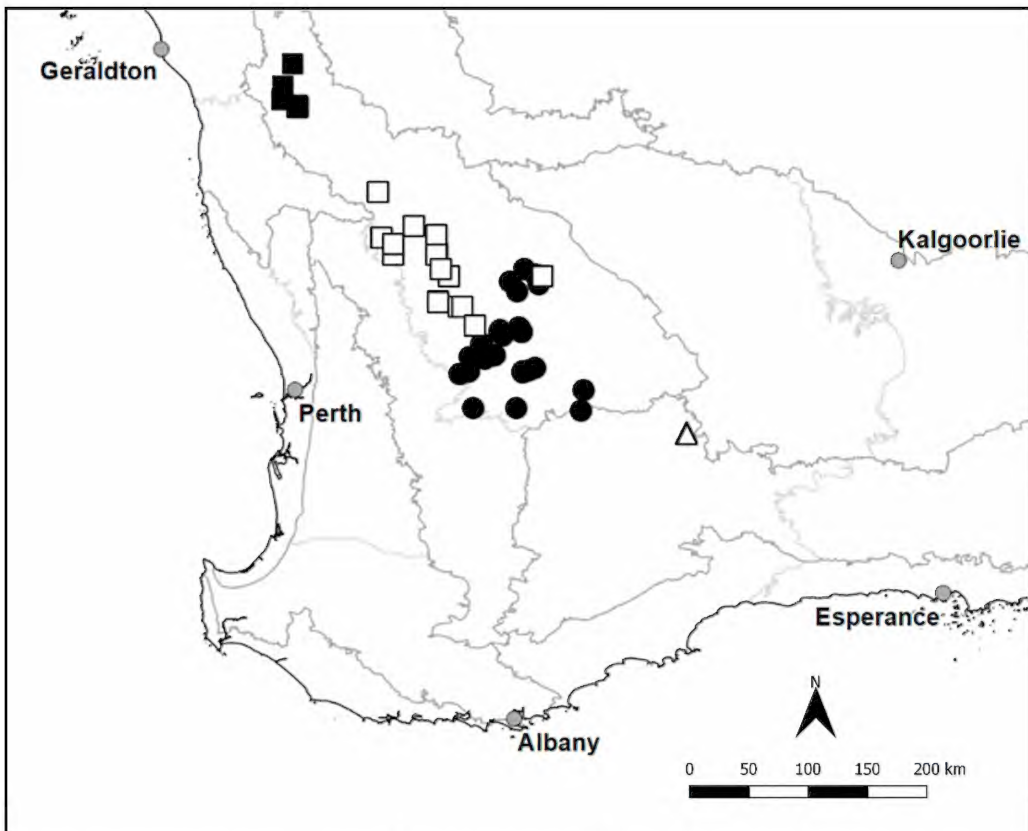


Figure 6. Distribution of *Balaustion exsertum* (●), *B. hemisphaericum* (■), *B. interruptum* (□) and *B. multicaule* (△).

long. The two bracteoles subtending a flower are sometimes borne at quite different levels, having a short stalk between them and then a further pedicel above and peduncle below. This is common on some specimens such as *R.J. Cranfield & P.J. Spencer* 7853.

4. *Balaustion interruptum* Rye, *sp. nov.*

Type: c. 200 m N of Old Koorda Road on Dowerin–Kalannie Road, NW of Dowerin, Western Australia, 26 September 2021, *J.A. Wege & B.P. Miller* JAW 2132 (*holo:* PERTH 09447148; *iso:* CANB, K, MEL, NSW).

Baeckea cryptonoma Trudgen ms, in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 347 (2000); Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022], *ex parte*.

Baeckea sp. Burakin (M.E. & M.E. Trudgen 1423), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Illustration. Drawing on *C.A. Gardner* 2717 (PERTH 03350061).

Shrub 0.3–0.8 m high or rarely up to 1.7 m high, commonly 0.5–0.8 m wide; flowering branchlets with usually 1–3 pairs of flowers. *Leaves* antrorse to patent. *Petioles* 0–0.2 mm long. *Leaf blades* ± oblong to narrowly oblong-obovate in outline, 1.3–2.5 mm long, 0.5–1.3 mm wide, 0.5–0.7 mm thick, truncate or slightly obtuse, entire or distally denticulate on a narrow scarious margin; abaxial surface deeply convex (with almost parallel sides), oil glands in 2 or 3 main rows on each side of midvein, few per row; adaxial surface fairly flat. *Peduncles* 2–4 mm long. *Bracteoles* ± opposite to *c.* 1 mm separated, persistent, ovate or broadly ovate, 1–1.4 mm long. *Pedicels* (0–)0.5–1.5 mm long. *Flowers* 8–12 mm diam. *Hypanthium* ± broadly obconic, 1.5–1.8 mm long, 2–2.5 mm diam., pitted-rugose on adnate part; free part 0.35–0.5 mm long. *Sepals* depressed ovate, 0.5–0.9 mm long, 1.3–1.6 mm wide, herbaceous part usually ridged, often greenish and gland-dotted or pitted-rugose along lower midvein; petaloid margin 0.35–0.5 wide, largely deep pink, with a white edge, entire. *Petals* 3–4.75 mm long, 2.75–4.75 mm wide, white or pale pink, minutely denticulate on the margin. *Stamens* usually 13–20, free, widely spaced. *Antipetalous filaments* 1.1–1.5 mm long, up to *c.* 0.2 mm wide at the base. *Anthers* *c.* 0.3 mm wide from front view; connective gland 0.25–0.4 mm long, orange-brown or pink; thecae 0.2–0.3 mm long, maroon. *Ovary* *c.* 2/3 inferior; ovules 4–8. *Style* 1.6–2.3 mm long; stigma 0.2–0.25 mm diam. *Fruits* 1/2–2/3 superior, *c.* 2 mm long, *c.* 2.5 mm diam.; placentas much raised at centre, broadly ovate to circular in outline, *c.* 0.5 × 0.5 mm. *Seeds* *c.* 1.2 mm long, *c.* 0.5 mm wide, *c.* 0.6 mm thick, golden brown and markedly colliculate; inner cavity 0.6–0.7 mm long. (Figure 7A)

Diagnostic features. Distinguished by the following combination of characters: hypanthium ± broadly obconic, 1.5–1.8 mm long; sepals 0.5–0.9 mm long; stamens usually 13–20, widely spaced.

Selected specimens examined. WESTERN AUSTRALIA: Rabbit Proof Fence Rd, N of Minnivale, 15 Oct. 2013, *R. Davis, A.J. Perkins & B.L. Rye* DPR 08 (NSW, PERTH); Minnivale North East Rd, 0.3 km E of King Rd, Minnivale Nature Reserve, 18 Oct. 2013, *R. Davis & B.L. Rye* DR 06 (AD, PERTH); Ballidu, 23 Sep. 1931, *C.A. Gardner* 2717 (PERTH, 3 sheets); Petrudor Rock Reserve, SE of Dallwallinu, 17 Sep. 1999, *M. Hislop* 1682 (PERTH); Dowerin–Kalannie Rd, 400 m N from the junction with Kokardine East Rd, Kokardine, 1 Nov. 2008, *F. & J. Hort* 3356 (AD, BRI, PERTH); Konnongorring, 17 Aug. 1925, *E.H. Ising* 122 (AD); Mindah Holdsworth Rd, *c.* 25 km NE of Wyalkatchem townsite, 4 Sep. 1999, *C. Keating et al.* WYHO 9/75 (PERTH); 28.8 mi. [46 km] S of Kulja, 16 Oct. 1972, *C.I. Stacey* 227 (PERTH, 2 sheets); 0.5 km S of Burakin then 0.4 km NE, 31 Aug. 1975, *M.E. & M.E. Trudgen* 1423 (BRI, CANB, MEL, PERTH).

Distribution and habitat. Extends from Petrudor Rock Reserve south-east to Wyalkatchem, with an isolated record from near Mukinbudin (Figure 6). Occurs in yellow to brown sandy soils, sometimes with gravel, with the dominant species often from the genera *Eucalyptus* (especially mallee species), *Allocasuarina*, *Melaleuca* or *Acacia*.

Phenology. Flowers mainly August to October, with mature fruits recorded at the beginning of December.

Etymology. From the Latin *interruptus* (broken in pieces, interrupted), referring to the presence of gaps in the circle of stamens.

Conservation status. Not considered to be at risk.

Affinities. See discussion under *B. hemisphaericum*.

Notes. The name '*Baeckea cryptonoma* Trudgen ms' was applied originally to the specimen that has



Figure 7. Images of *Balaustion* species. A – flowering branch of *B. interruptum*, showing distinctly separated filaments; B – flowering branch of *B. grandibracteatum* subsp. *juncturum* with a pair of flowers, showing broad, almost contiguous filaments and anthers with a pink connective gland and maroon thecae. Photographs by Juliet Wege (A, from *J.A. Wege & B.P. Miller* JAW 2132) and Kevin Thiele (B, from *K.R. Thiele* 4700).

now been selected to be the holotype of *Balaustion interruptum*, but was later applied to specimens of both *B. hemisphaericum* and *B. interruptum* as the two taxa were considered to be synonymous. One atypical specimen from Wubin (*S. de la Hunty s.n.*, 5 Sep. 1959) has 26 stamens.

Although many specimens of *B. interruptum* have a majority of their leaves less than 1 mm long, they all have some leaves 1.3 mm or longer. Mature fruits and seeds were observed on only one specimen. More fruiting material is needed to gain a reliable range of fruit and seed measurements.

C. *Balaustion* sect. *Tilophloia* Rye, *sect. nov.*

Type: Balaustion grandibracteatum (E.Pritz.) Rye.

Tilophloia Trudgen & Rye ms; B.L. Rye, *Nuytsia* 19: 129–148 (2009).

Shrubs prostrate or up to 1.2 m high; flowering branchlets usually with 1 or 2 flowers but sometimes apparently more when flowers are borne on very short lateral branchlets, or rarely with up to 3 consecutive nodes bearing flowers. *Young stems* with a sub-epidermal tissue that disintegrates into fine fibres. *Leaves* with petiole very well defined; blade sometimes with a subterminal point or knob, the apical point absent or minute. *Bracteoles* scarious, pale and translucent to reddish. *Pedicels* absent to long. *Flowers* with hypanthium and sepals distinct in their colouring from the petals. *Hypanthium* broadly obconic to very broad and 5-lobed, adnate to ovary for most of its length. *Sepals* usually somewhat herbaceous and green with a white petaloid border or tinged reddish. *Petals* widely spreading, usually white or pink, and minutely denticulate or entire (but orange and denticulate in *B. tangerinum*). *Stamens* 14–30, all or mostly free, contiguous or close, with a subterminal, 90° bend. *Broadest filaments* (excluding any connate pairs) 0.2–0.6 mm wide at base. *Anthers* horizontal, attached almost at base of connective gland to the free filament, dehiscent by two elliptic pores or short slits that tend to diverge at the base; connective gland conspicuous, distinctly longer than the thecae. *Ovary* 1/2–2/3 inferior; ovules (8–)10–22 per loculus. Fruits 2/3 inferior to 2/3 superior, not hidden by the hypanthium, which is often rugose-pitted or somewhat rugose except for a smooth rim 0.5–0.8 mm wide at the top. *Seeds* 1.2–1.8 mm long, golden brown to moderately dark brown, colliculate.

Diagnostic features. Distinguished from the other two sections by its greater tendency for the stem outer layers to disintegrate into numerous fibres and in having the stamen filaments broader in comparison with their length.

Size and distribution. Comprises 14 named species and two subspecies, with three additional taxa housed under phrase names. Section *Tilophloia* occurs in the Avon Wheatbelt and Mallee bioregions of the South West Botanical Province and the Yalgoo and Coolgardie Bioregions of the Eremaean Botanical Province (Figure 4), extending from Diemals Station south to Lake Grace.

Etymology. From the Greek *tilos* (thread, fibre) and *phloios* (bark), referring to the disintegration of the young stem epidermis into loose fibres before it is shed from the stems.

Notes. This section was referred to in the key to genera and sections given in Rye (2009b) as *Tilophloia* ms without any authorship or taxonomic level indicated.

The broadest filaments are usually 0.2–0.6 mm wide at the base, but occasionally filaments 0.5–1 mm wide are formed by amalgamation of two adjacent stamens, with two anthers at the top. There may

be a few pairs of partially or fully united stamens in a flower. There may also very rarely be a triplet of stamens united at the base.

Two main species groups can be distinguished on the basis of leaf morphology, the typical group having a rounded apex without a subterminal dorsal projection (Figure 1E & F) and the other group with the keel produced into a subterminal knob or small point (Figure 1A–D). The ratio of petal length to stamen filament length tends to be higher among the typical group but there is considerable overlap in this character.

Anthers often have deep pink colouration on the connective gland and/or thecae in fresh material.

5. *Balaustion baiocalyx* Rye, *sp. nov.*

Type: between Bencubbin and Koorda, Western Australia, 8 October 1937, *W.E. Blackall* 3371 (*holo:* PERTH 06748457; *iso:* CANB, PERTH 06748430, PERTH 06748449).

Baeckea sp. Koorda (W.E. Blackall 3371), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Illustration. Drawing on *W.E. Blackall* 3371 (PERTH 06748457).

Shrub 0.3–0.9 m high, commonly 0.15–0.6 m wide, single-stemmed at base; flowering branchlets with 1 pair of flowers. *Leaves* appressed to widely antrorse. *Petioles* 0.3–0.5 mm long. *Leaf blades* commonly obovate, 2–5 mm long, 1–2 mm wide, not very thick, obtuse, minutely serrulate or entire, slightly recurved at apex; abaxial surface convex, keeled towards apex, the keel distally rounded, with the larger oil glands usually in 3 or 4 main rows on each side of midvein; adaxial surface shallowly concave (or shallowly indented), with less obvious oil glands. *Peduncles* 3–4.5 mm long, somewhat glandular and with longitudinal patterning. *Bracteoles* shed from young or medium-sized buds, *c.* 2 mm long. *Pedicels* 0.5–1.5 mm long. *Flowers* commonly 12–14 mm diam. *Hypanthium* 2–3 mm long, 3.5–4.5 mm wide (increasing in fruit to a maximum of 4 × 6 mm), green and somewhat rugose throughout; free part 0.3–0.5 mm long. *Sepals* often difficult to see as very reduced and tending to curve inwards, 0.5–0.8 mm long, 2–3 mm wide, with little or almost no petaloid border, \pm entire. *Petals* 4–5 mm long, white. *Stamens* commonly 22–24. *Antipetalous filaments* *c.* 2 mm long. *Anthers* *c.* 0.5 mm wide; connective gland *c.* 0.6 mm long; thecae *c.* 0.3 mm long. *Ovary* *c.* 2/3 inferior; ovules 18–20 per loculus. *Style* 2.6–3.2 mm long; stigma *c.* 0.25 mm diam. *Fruits* just over 1/2 inferior, 4–6 mm long, 5–6 mm diam.; placentas elliptic or ovate, *c.* 2 × 1.3 mm. *Seeds* reniform but somewhat faceted, 1.3–1.7 mm long, 0.6–0.85 mm wide, 0.9–1.2 mm thick, golden brown, colliculate; inner cavity 0.6–0.7 mm long. (Figure 1E & G)

Diagnostic features. Distinguished from other species of *Balaustion* by its particularly reduced sepals. Other important characters: leaves with a distally rounded keel, not much thickened; bracteoles *c.* 2 mm long.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 8 Sep. 1995, *P. Armstrong s.n.* (PERTH); Oct. 1937, *W.E. Blackall* 3513 (PERTH); 19 Nov. 2013, *A. Crawford* ADC 2414 (MEL, PERTH); 1 Dec. 2008, *M.E. Trudgen* 23333 A (CANB, PERTH); 1 Dec. 2008, *M.E. Trudgen* 23333 C (NSW, PERTH).

Distribution and habitat. Extends from near Kalannie to south of Dowerin and east of Koorda (Figure 8). There is one record from grey sand and another from yellow sand, the latter from *Melaleuca* low

shrubland with patches of *Allocasuarina* nearby.

Phenology. Flowers recorded from early September to November. Mature fruits recorded in November and December.

Etymology. From the Greek *baios* (small, scanty) and *kalyx* (calyx), referring to the very reduced sepals (Figure 1G) that may appear to be absent.

Conservation status. Listed as Priority One under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Baeckea* sp. Koorda (W.E. Blackall 3371).

Affinities. *Balaustion baiocalyx* is readily distinguished by its very reduced sepals. It belongs in the typical group of sect. *Tilophloia* but is superficially similar to *B. polyandrum*, which belongs to the species group that has leaves commonly with a subterminal point or knob.

Notes. Better flowering material is needed for this species.

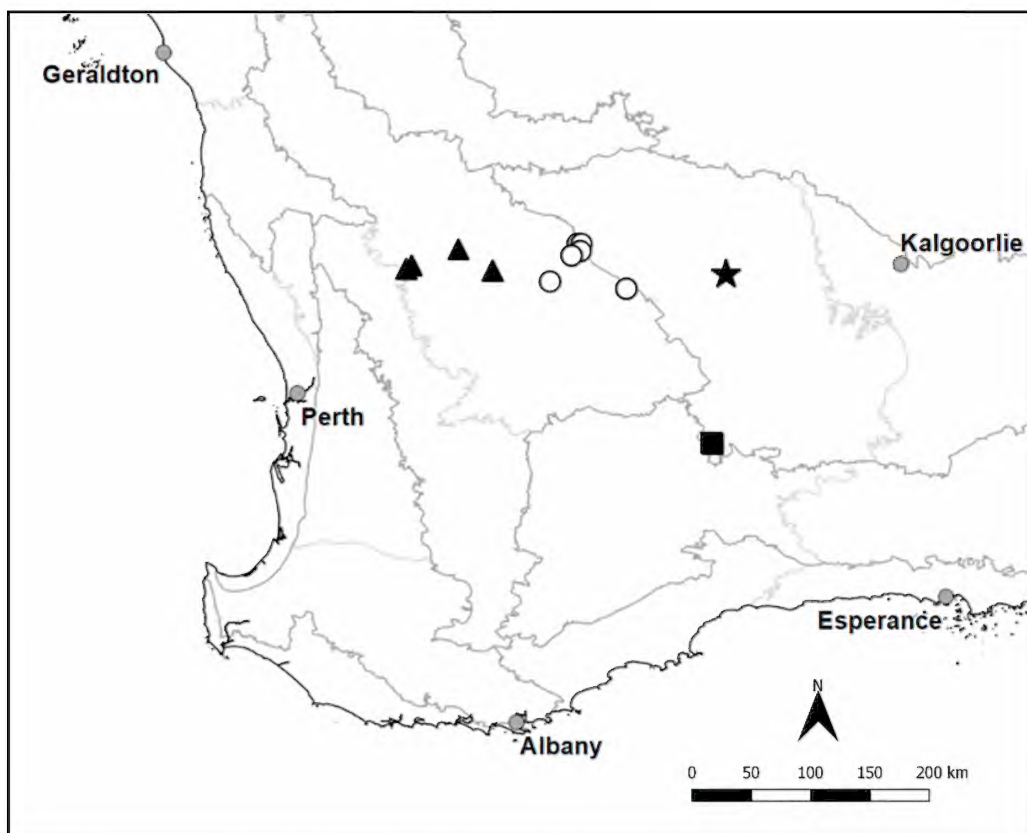


Figure 8. Distribution of *Balaustion baiocalyx* (▲), *B. filifolium* (○), *B. polyandrum* (★) and *B. sp.* North Ironcap (■).

6. *Balaustion bimucronatum* Rye, *sp. nov.*

Type: south of Mukinbudin, Western Australia [precise locality withheld for conservation reasons], 15 October 2003, *M.E. Trudgen & B.L. Rye* MET 22077 (*holo:* PERTH 06748295; *iso:* CANB, K, MEL).

Baeckea sp. Stockton Road (M.E. Trudgen MET22077 & B. Rye), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Shrub c. 0.2 m high, c. 0.35 m across; flowering branchlets with 1 pair of flowers or more commonly just a solitary flower. *Leaves* mostly widely antrorse. *Petioles* 0.4–0.6 mm long. *Leaf blades* mostly narrowly ovate to linear but a few ovate or narrowly obovate, 2.5–3.5 mm long, 0.8–1.2 mm wide, 0.4–0.5 mm thick, with a minute apical mucro less than 0.1 mm long, minutely denticulate at first; abaxial surface convex, somewhat recurved at apex, keeled towards the apex and often grooved along the midvein below, the keel often developed into a subterminal point of similar size to the apical mucro, with the larger oil glands usually in 1 or 2 main rows on each side of midvein; adaxial surface fairly flat, often with a central longitudinal groove, with less obvious oil glands. *Peduncles* 2–5 mm long. *Bracteoles* caducous or rarely persistent at anthesis, 2–3.5 mm long. *Pedicels* 0.6–2 mm long. *Flowers* 10–11 mm diam. *Hypanthium* obconic in bud, becoming more hemispherical in flower and fruit, c. 2 mm long, 3.5–4 mm diam., green, rugose-pitted; free part 0.6–0.8 mm long. *Sepals* very broadly ovate, pink-tinged towards base and centre, or with an irregular white border or irregularly pink markings reaching the margins, 1.2–1.5 mm long, 1.8–2.5 mm wide, serrulate or minutely lacinate. *Petals* 3.5–4 mm long, white, the outer ones with some pink outside. *Stamens* 16–21, often with a few pairs connate for some distance. *Antipetalous filaments* 2–2.2 mm long. *Anthers* c. 0.5 mm wide from front view; connective gland 0.4–0.5 mm long; thecae 0.2–0.25 mm long. *Ovary* c. 1/2 inferior; ovules 12–14 per loculus. *Style* c. 3.4 mm long; stigma c. 0.25 mm diam. *Fruits* c. 1/2 inferior, c. 3.5 mm long, 3.5–4 mm diam.; placentas elliptic or elliptic-ovate, c. 2.2 × 1.5 mm. *Seeds* faceted-reniform, 1.3–1.4 mm long, 0.6–1 mm wide, 0.6–0.8 mm thick, golden brown, minutely colliculate; inner cavity 0.7–0.8 mm long. *Chaff pieces* somewhat paler than the seeds.

Diagnostic features. Distinguished from other species of *Balaustion* that commonly have leaves with a 2-pointed apex by the following combination of characters: bracteoles caducous or rarely persistent at anthesis, 2–3.5 mm long; pedicels 0.6–2 mm long; ovules 12–14 per loculus.

Other specimen examined. WESTERN AUSTRALIA: [locality withheld for conservation reasons] 14 Oct. 2006, *A. Crawford & N. Sheehy* ADC 1186 (PERTH).

Distribution and habitat. Recorded from south-east of Mukinbudin (Figure 5) in yellow sand with mallees, *Acacia* and *Thryptomene kochii*.

Phenology. Flowers and fruits recorded in October.

Etymology. From the Latin *bi-* (two-) and *mucronatus* (mucronate) as the leaves commonly have both a subterminal mucro and an apical one.

Conservation status. Listed as Priority One under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Baeckea* sp. Stockton Road (M.E. Trudgen MET22077 & B. Rye).

Affinities. *Balaustion bimucronatum* is somewhat intermediate in morphology between *B. muginbudin* and *B. spenceri* (see Table 2). The closest locality of *B. muginbudin* is about 25 km to the north-east of *B. bimucronatum*. *Balaustion muginbudin* is readily distinguished from *B. bimucronatum* by its longer bracteoles and sepals, and shorter pedicels and style. It also tends to have shorter petioles and a different leaf shape.

Balaustion spenceri, which occurs more than 50 km east of *B. bimucronatum*, differs in its shorter bracteoles and in having pedicels more or less equal to or much longer than the peduncles. A major concern with recognising both *B. bimucronatum* and *B. spenceri* as distinct species, rather than as subspecies or variants of other taxa, is that each is only known from a single population. If more populations had been found, more reliable descriptions could have been drawn up, with a greater range of measurements for most characters. On the available evidence, however, both taxa can be reliably distinguished from one another and from all other members of the genus.

7. *Balaustion exsertum* (S.Moore) Rye, *comb. nov.*

Baeckea exserta S.Moore, *J. Linn. Soc., Bot.* 45: 177 (1920). *Type:* Bruce Rock, Western Australia, 1917, *F. Stoward* 427 (*holo:* BM 000797537).

Baeckea sp. Eujiny (J. Buegge D 99), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Baeckea sp. Kellerberrin (C.A. Gardner s.n. PERTH 03351009), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Baeckea sp. Tammin (R. Coveny 8319 & B. Habberley), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Baeckea sp. Tambia Hill (J.C. Anway 327), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Illustrations. W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildfl.* 3A: 83 (1980) [as *Baeckea exsertum*]; drawing on C.A. Gardner 2749 (PERTH 07478941).

Table 2. Comparison of three geographically restricted species of *Balaustion* from east of Muginbudin.

| Species | <i>B. muginbudin</i> | <i>B. bimucronatum</i> | <i>B. spenceri</i> |
|------------------|----------------------|------------------------|--------------------|
| Petiole length | 0.3–0.5 mm | 0.4–0.6 mm | 0.4–0.5 mm |
| Leaf width | (1–)1.2–1.8 mm | 0.8–1.2 mm | 0.6–1.1 mm |
| Peduncle length | 2.5–4 mm | 2–5 mm | 1–2.5 mm |
| Bracteole length | 4–5.5 mm | 2–3.5 mm | 1.3–1.6 mm |
| Pedicel length | 0–0.3 mm | 0.6–2 mm | 2–3.5 mm |
| Sepal length | 1.4–2.5 mm | 1.2–1.5 mm | 0.8–1.5 mm |
| Petal length | 4–6.5 mm | 3.5–4 mm | 3.5–5 mm |
| Stamen number | 19–25 | 16–21 | 20–24 |
| Style length | 1.9–2.5 mm | c. 3.4 mm | 2.6–3.3 mm |

Shrub low-growing, often ground-hugging, usually 0.1–0.3 m high, 0.3–1.5 m wide; flowering branchlets mostly with 1 or 2 flowers at a single node (rarely more per node in one specimen with whorled leaves). *Leaves* widely spreading in dense clusters on short lateral branchlets but tending to be closely antrorse to appressed on young shoots or older stems. *Petioles* 0.3–0.6 mm long. *Leaf blades* commonly narrowly oblong in outline, broadest towards the top (or at least not right at the base), (1.3–)1.5–4.5(–5) mm long, 0.5–1(–1.2) mm wide, 0.4–0.5 mm thick, entire or minutely denticulate; abaxial surface keeled towards apex and narrowly furrowed below, the keel prominent just below the apex as a knob or tending to form a subterminal point, with the larger oil glands usually in 1 or 2 main rows on each side of midvein; adaxial surface slightly convex to flat, often with a narrow furrow along the centre, with less obvious oil glands. *Peduncles* 1.3–4.5 mm long. *Bracteoles* borne well below the mature buds, widely antrorse, often persistent, 0.8–1.6(–2) mm long. *Pedicels* 1.2–3.5 mm long. *Flowers* 8–12 mm diam. *Hypanthium* usually broadly obconic, occasionally appearing a little more hemispherical with broadly rounded antisepalous ‘ridges’, 1.3–2 mm long, 3–3.5 mm wide, very rugose-pitted (and green in adnate part, with a smoother brownish/purplish rim in distal c. 0.6 mm); free part 0.4–0.5 mm long. *Sepals* depressed ovate, 1–1.8 mm long, 2–3(–3.5) mm wide, scarious, reddish within a broad pale border or with scarcely any pale border (sometimes with reddish parts irregularly extending into the broad pale border), minutely serrulate to laciniate. *Petals* 3–6 mm long, white. *Stamens* 17–24. *Antipetalous filaments* 2–3(–3.3) mm long. *Anthers* 0.3–0.4 mm wide from front view; connective gland 0.3–0.4 mm long, pink; thecae 0.2–0.3 mm long. *Ovary* c. 1/2 inferior; ovules 9–15 per loculus. *Style* 2.5–4 mm long; stigma 0.15–0.2 mm diam. *Fruits* c. 2/3 superior, 2.5–3.5 mm long, 3–4 mm diam.; placentas elliptic, 1.6–2.4 × 1.3–1.6 mm. *Seeds* faceted-reniform, 1.3–1.8 mm long, 0.5–0.85 mm wide, 0.6–0.8 mm thick, medium brown, minutely colliculate; inner cavity 0.6–1 mm long.

Diagnostic features. Distinguished from other species of *Balaustion* that commonly have a 2-pointed apex or subterminal knob to the leaves by the following combination of characters: bracteoles borne well below the mature bud, 0.8–1.6(–2) mm long, often persistent in flower; hypanthium usually broadly obconic; style 2.5–4 mm long; ovules 9–15 per loculus.

Selected specimens examined. WESTERNAUSTRALIA: [localities withheld for conservation reasons] 2 Sep. 1965, *J.C. Anway* 327 (PERTH); 1893, *M. Cronin* s.n. (MEL); 30 Sep. 2010, *B. Hort* NM 242 (PERTH); 13 Sep. 2013, *B. Hort* s.n. (PERTH); 7 Aug. 2008, *B. Lullfitz*, *A. Konnur* & *H. Cannon* BRL 61 (PERTH); 8 Sep. 1974, *B.L. Powell* 74085 (PERTH).

Distribution and habitat. Extends from Kodi Kodjin Nature Reserve (south of Trayning) south-east to the Quairading area and south-west to the Narembreen area (Figure 6). The soil is commonly yellow to brown or grey sand, sometimes mixed with clay, and the vegetation commonly dominated by eucalypts, *Allocasuarina* and *Melaleuca*.

Phenology. Flowers from August to October, with mature fruits recorded in October and November.

Etymology. From the Latin *exsertus* (protruding), referring to the exposed stamens, which are longer than those of several close relatives.

Conservation status. Despite its expanded circumscription, this species retains its Priority Three status under Conservation Codes for Western Australian Flora (Western Australian Herbarium (1998–), as *Baeckea exserta*. The synonyms *B. sp. Eujiny*, *B. sp. Kellerberrin* and *B. sp. Tampia Hill* were previously listed as Priority One, and *B. sp. Tammin* as Priority Three. Although there are numerous

collections spanning a distribution c. 130 km long, the landscape is highly cleared and there are few recent collections in the north of its range.

Chromosome number. $n = 11$ (Rye 1979), vouchers B.L. Powell 74058 [as *Baeckea grandis*] and B.L. Powell 74085 [as *B. grandiflora* Benth.].

Co-occurring species. There are no definite records of *B. exsertum* co-occurring with any other member of the genus but central and south-eastern populations of *B. exsertum* occur within the range of *B. quinquelobum*, and the habitat descriptions of the two species are similar.

Variants. A western variant that has been known as *Baeckea* sp. Tammin has consistently short leaves, with the larger ones usually 1.5–2.5 mm long. This seems to match the protologue of *B. exserta* which records the leaves as 1.5–2 mm long for the type specimen from Bruce Rock, although more recently collected specimens from the Bruce Rock area have their largest leaves mostly 2.5–4.5 mm long, and a particularly long-leaved specimen (*B. Hort s.n.* PERTH 08637148) has leaves up to 5 mm long. *Baeckea* sp. Tammin also has consistently short petals 3–4.3 mm long, again matching the protologue which gives them as 3.5 mm long, whereas other specimens have more variable petal length up to 6 mm long. The specimen on which the name *Baeckea* sp. Kellerberrin was based is like the Tammin variant in leaf and petal size whereas the name *B. sp.* Tampia Hill is based on a south-eastern specimen with slightly longer leaves and petals.

One collection from near Bruce Rock was given the phrase name *Baeckea* sp. Eujinjyn (*J. Bruegge* D 99). It has broader, flatter leaves than usual for *Balaustion exsertum*, often with two main rows of oil glands on each side of the midvein, whereas it is much more common in *B. exsertum* for leaves to have just one main row of oil glands. Broad leaves are found on some specimens of *B. exsertum* that also have the typical thick leaves; for example *B.G. Muir* 303 (3.16) has flat leaves on rapidly growing young branchlets. The very unusual height record of 0.8 m for *J. Bruegge* D 99 suggests that this population is distinctive but it could have been taken from a plant that was propped up by adjacent vegetation or it could be an inaccurate record.

Although considerable variation occurs across the range of the populations included here as *B. exsertum*, no clear-cut differences have been found to warrant recognition of more than one species. Further investigation of the *B. exsertum* group is needed to determine whether any variants should be recognised as subspecies.

Affinities. Similar to *B. quinquelobum*, which differs in having projecting basal lobes on the hypanthium, shorter stamens, a shorter style, and usually broader bracteoles with a greater tendency to be persistent, although the difference in bracteole shape may be just a consequence of the difference in hypanthium shape between the two taxa. An unpublished name, *Baeckea grandis* var. *exserta* (S. Moore) C.A. Gardner ms, is discussed under *Balaustion quinquelobum* because it was applied to an old collection of *B. quinquelobum*, which was previously included within *Baeckea exserta*.

Two other similar taxa are *B. filifolium* and *B. spenceri* (see notes under those species).

Notes. The connective gland in *B. exsertum* is often deep pink on relatively fresh material, but occasionally the thecae may be deep pink instead, or perhaps both parts of the anther deep pink, although they seem never to be identical in colour. The style seems to be pale at first, becoming deep pink to red in fruit.

One specimen of the Tammin variant (*R. Coveny* 8319 & *B. Habberley*) has its leaves mostly in whorls of three, although apparently still only with one or two flowers per node. However, one flowering branchlet has four leaves on some of its nodes, including one node with four flowers. The occurrence in this position also of some closely paired leaves and two apparently fused leaves suggests that all odd leaf arrangements in this specimen are an abnormality.

One specimen from the Quairading area (*B. Hort* 3466) is unusual in having bracteoles up to 2 mm long.

8. *Balaustion filifolium* Rye, *sp. nov.*

Type: Beringbooding, Western Australia, 11 September 1957, *A.R. Main s.n. (holo: PERTH 06748317)*.

Baeckea sp. Beringbooding (A.R. Main 11/9/1957), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Shrub prostrate or low-growing, 0.2–0.5 m high, 0.5–1.4 m wide; flowering branchlets mostly with 1 pair of flowers. *Leaves* widely spreading in dense clusters on short lateral branchlets but tending to be closely antrorse to appressed on older stems. *Petioles* 0.1–0.2 mm long. *Leaf blades* narrowly ovate-triangular to long-linear in outline, broadest at the base, 3–7 mm long, 0.2–0.3 (–0.4) mm wide, 0.2–0.3 mm thick, with a minute apical mucro less than 0.1 mm long, entire; abaxial surface deeply convex, grooved along midvein for most of its length, the keel produced near apex into a prominent knob or dorsal point (the apex often appearing double-pointed), with the larger oil glands in 1 or less often 2 main rows on each side of midvein; adaxial surface flat, with less obvious oil glands. *Peduncles* 1–6 mm long. *Bracteoles* usually caducous, rarely persistent in flower, 1.3–1.8 mm long. *Pedicels* 2–3.5 mm long. *Flowers* 9–13 mm diam. *Hypanthium* ± hemispherical, 1.5–2 mm long, 3–4 mm diam., somewhat rugose-pitted; free part *c.* 0.4 mm long. *Sepals* depressed ovate, red-tinged on outer surface, 1.2–1.8 mm long, 2–2.5 mm wide, minutely serrulate. *Petals* 4–5 mm long, pale pink. *Stamens* 16–24, sometimes with a few of them connate to an adjacent stamen for most of their length. *Antipetalous filaments* 2.2–3.4 mm long. *Anthers* 0.3–0.4 mm wide from front view; connective gland *c.* 0.4 mm long; thecae 0.2–0.3 mm long. *Ovary c.* 1/2-inferior; ovules 10–16 per loculus. *Style* 3.5–3.8 mm long; stigma 0.15–0.2 mm diam. *Fruits c.* 2/3 superior, 2.5–3.5 mm long, 3–4 mm diam.; placentas elliptic, 1.4–1.7 × 0.8–1.25 mm. *Seeds* faceted-reniform, 1.3–1.55 mm long, 0.7–0.8 mm wide, 0.7–0.8 mm thick, medium brown, minutely colliculate; inner cavity 0.7–0.8 mm long. (Figure 1B)

Diagnostic features. Distinguished from other species that commonly have a 2-pointed apex or subterminal knob to the leaves by its narrow, entire leaves that are broadest at the base and have a very short petiole. Other important characters: bracteoles 1.3–1.8 mm long; pedicels at least half as long as the peduncles.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 17 Sep. 1965, *G. Byrne s.n.* (PERTH); 2 Oct. 2009, *B.R. Lullfitz* BRL 125 (PERTH, 2 sheets); 16 Aug. 1979, *P. de Rebeira* 141 (PERTH); 14 July 2007, *M. Squire* 002 (PERTH); 2 Dec. 2008, *M.E. Trudgen* MET 23346 A (NSW, PERTH); 2 Dec. 2008, *M.E. Trudgen* MET 23346 B (CANB, PERTH).

Distribution and habitat. Recorded from sandplains and associated with granite outcrops, extending from Beringbooding Rock (near Bonnie Rock) to west of Mukinbudin (Figure 8). Mostly recorded with *Acacia*. The sand colour is sometimes recorded as yellow or orange.

Phenology. Flowers recorded from August to October and mature fruits in November and December.

Etymology. From the Latin *filum* (a thread) and *-folius* (-leaved), referring to the usually slender leaves, which can be narrower than in any other member of the genus.

Conservation status. Listed as Priority Two under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Baeckea* sp. Beringbooding (A.R. Main 11/9/1957). The species is known from one nature reserve.

Affinities. Very similar to *B. exsertum* but occurring further north and with shorter petioles and entire, usually longer leaf blades that are broadest at the base. *Balaustion quinquelobum* is also similar to *B. filifolium* but has a 5-lobed hypanthium, shorter stamens and style, and shorter leaves that are denticulate at first; it also appears to be geographically separated although not by a great distance.

Notes. *Balaustion filifolium* usually has only 16–19 stamens, fewer on average than in any related species, but *M. Squire* 002 has up to 24 stamens that seem particularly long in relation to the petal length. Two collections are described as having a domed habit.

9. *Balaustion grandibracteatum* (E.Pritz.) Rye, *comb. nov.*

Baeckea grandibracteata E.Pritz. in L. Diels & E. Pritzel, *Bot. Jahrb. Syst.* 35: 417 (1904). *Type:* near Southern Cross, Western Australia, November [1901], *L. Diels* 5593 (*holo:* B n.v., presumably destroyed in WWII). *Neotype:* east of Southern Cross, Western Australia [precise locality withheld for conservation reasons], 30 September 1931, *C.A. Gardner* 2778 (*neo:* PERTH 03349705, here designated; *isoneo:* AD, CANB, K, MEL, NSW).

Illustration. W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildfl.* 3A: 80 (1980) [as *Baeckea grandibracteata*].

Shrub 0.2–0.8 m high, 0.3–0.8 m wide; flowering branchlets with up to 4 nodes bearing pairs of flowers or solitary flowers, but most commonly just one node. *Leaves* widely antrorse to appressed, commonly \pm appressed for long distances along unbranched sections of stems. *Petioles* 0.1–0.6 mm long. *Leaf blades* mostly narrowly oblong-elliptic in outline, 2–5 mm long, 0.7–1(–1.5) mm wide, 0.4–0.7 mm thick, obtuse, not mucronate or with mucro less than 0.1 mm long, with denticulate margins at first, usually becoming entire; abaxial surface convex, sometimes broadly furrowed towards the base, keeled above, the keel distally rounded (gently curved down to the apex), with the larger oil glands in 1–3 main rows on each side of midvein; adaxial surface \pm flat, often with a longitudinal central furrow, with less obvious oil glands. *Peduncles* 1–6 mm long, broad and somewhat compressed at summit, with rather prominent, often reddish, lateral ridges, the remainder green and rugose-pitted throughout or at least towards the summit with similar rugose-pitting to that on hypanthium. *Bracteoles* 2–6 mm long. *Pedicels* usually absent or very short. *Flowers* 10–15 mm diam. *Hypanthium* 1.7–3 mm long, 3.5–5 mm diam., green, rugose-pitted; free part c. 0.8 mm long, sometimes red-tinged. *Sepals* ovate to semi-elliptic or depressed ovate or depressed semi-circular, 0.6–2 mm long, 2.5–3 mm wide, reddish on outer surface, often with an irregular whitish margin 0.2–0.3 mm wide, minutely laciniate. *Petals* 4–6.5 mm long, white. *Stamens* 14–27. *Antipetalous filaments* 1.3–2.1 mm long. *Anthers* c. 0.4 mm wide from front view; connective gland 0.4–0.5 mm long; thecae 0.2–0.3 mm long. *Ovary* c. 2/3 inferior; ovules 13–20 per loculus. *Style* 1.6–2.5 mm long; stigma 0.2–0.25 mm diam. *Fruits* c. 2/3 superior, 3–3.5 mm long, 4.5–5 mm diam.; placentas ovate or broadly ovate, 1.8–2.35 \times 1.3–1.4 mm. *Seeds*

1.3–1.7 mm long, 0.5–0.8 mm wide, 0.75–0.85 mm thick, becoming medium brown, colliculate, the outer surface somewhat smoother than lateral surfaces; inner cavity 0.6–0.8 mm long.

Diagnostic features. Distinguished from other species of *Balaustion* that have leaves with the keel distally rounded (not pointed or knobbed) in having the following combination of characters: thick leaves 0.7–1(–1.5) mm wide; style 1.6–2.5 mm long.

Distribution. Recorded from the Southern Cross area south-west to the Hyden area and south-east to Frank Hann National Park (Figure 5).

Etymology. From the Latin *grandis* (large, great) and *bracteatus* (bracteate), because the typical variant has large bracteoles that enclose the mature flower buds and are often retained in fruit. Two other species, *B. mukinbudin* and *B. karroun*, have similarly large bracteoles.

Typification. A neotype is selected for this species from amongst material collected near Southern Cross as the type specimen from this locality, *L. Diels* 5593, appears to have been destroyed during WWII. The neotype has a suitable number of duplicates and was compared against the holotype at B on 24 August 1937 by Gardner, whose determinavit indicated that it was identical with the type.

Affinities. *Balaustion grandibracteatum* is similar to *B. multicaule*, which is distinguished by its particularly narrow leaves and its multi-stemmed habit.

Variation. Many phrase names have been applied to the *B. grandibracteatum* complex, based primarily on differences in sepal shape, bracteole persistence and the sizes of these two organs as well as peduncle shape and length, pedicel length and hypanthium shape. Some of these characters may have appeared to be diagnostic when very few specimens were available for study, but it is now clear that measurements and shapes can vary considerably within populations (see below). No reliable differences have been found to allow recognition of more than one species except for *B. multicaule*, which occurs on the western margin of the distribution of the complex.

Northern specimens of *B. grandibracteatum* have conspicuous bracteoles 4–6 mm long, which are large enough to enclose late buds and are often persistent even after the fruits have dehisced. In the southernmost specimens, bracteoles are 2–3 mm long and are mostly shed prior to anthesis. In the central part of the distribution, bracteoles are closer in size to the northern populations but are mostly shed prior to anthesis as in the southern populations. This means that bracteole persistence can be used to distinguish the typical variant from all central and southern populations. Some central and southern specimens, especially those in fruit, lack bracteoles but the likely size of the bracteoles can be inferred by the length of the pedicels as specimens with short bracteoles have longer pedicels than those with long bracteoles.

Petiole lengths tend to be the shortest in the northern populations, while some of the central and southern populations tend to have the most densely denticulate young leaves. Other characters, such as sepal size and shape, can vary greatly within populations (see *Variation* under subsp. *juncturum*) and so have not proved useful in delimiting infraspecific taxa.

Sepal shape varies from depressed semi-circular to ovate. Ovate or broadly ovate sepals often have a triangular apex whereas very short sepals are level across the top.

Notes. Three subspecies are recognised, occurring in the northern, central and southern parts of the distribution respectively. Differences between them are based primarily on two bracteole characters that have been used to distinguish species elsewhere in the genus; however, the lack of any clear disjunctions in the morphology does not support recognition of multiple species in this case.

9a. *Balaustion grandibracteatum* E.Pritz. subsp. *grandibracteatum*

Baeckea grandibracteata subsp. Parker Range (K. Newbey 9270), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Petioles 0.1–0.4 mm long. *Leaf blades* 2.5–5 mm long, 0.7–1(–1.5) mm wide, 0.4–0.6 mm thick. *Peduncles* 1–4.5 mm long. *Bracteoles* persistent at anthesis and often in late fruit, 4–6 mm long. *Pedicels* 0–0.4 mm long. *Sepals* 0.8–2 mm long. *Stamens* 18–23(–27). *Ovules* 13–19 per loculus. *Style* 1.8–2.5 mm long. (Figure 11)

Diagnostic features. Differs from the other two subspecies in having more persistent bracteoles and usually shorter petioles (0–0.4 mm *cf.* 0.3–0.5 mm long).

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 3 Oct. 1952, *P.H. Barrett* 4 (PERTH); Sep. 1929, *W.E. Blackall s.n.* (PERTH); 4 Oct. 1931, *W.E. Blackall* 874 (PERTH); 19 Oct. 1981, *L.A. Craven* 7198 (CANB *n.v.*, MEL *n.v.*, PERTH); 20 Oct. 1945, *C.A. Gardner* 8017 (AD, BRI, PERTH); 11 Oct. 1959, *C.A. Gardner* 12235 (PERTH); 18 Dec. 1993, *A.S. George* 17190 (NSW, PERTH); 15 Oct. 1994, *N. Gibson & M. Lyons* 2085 (PERTH); 15 Nov. 2011, *M. Hislop & J. Williams* MH 4167 (MEL, PERTH); 6 Oct. 1981, *K.R. Newbey* 9440 (PERTH); 10 Nov. 1982, *A. Strid* 21344 (PERTH); 4 Dec. 2008, *M.E. Trudgen* 23366 (CANB, PERTH); 30 Oct. 1974, *D.J.E. Whibley* 4708 (AD *n.v.*, PERTH); 14 Oct. 1997, *Peter G. Wilson* 1378 & *N. Lam* (NSW *n.v.*, PERTH).

Distribution and habitat. Recorded from west of Southern Cross to Yellowdine and south to near Mt Hampton and the Parker Range area (Figure 5), often from yellow sand. The dominant vegetation often includes *Allocasuarina* species such as *A. spinossissima* and/or *Grevillea*, *Callitris* and mallee species.

Phenology. Flowers recorded from September to December and mature fruits in early December.

Conservation status. Listed as Priority Three under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Baeckea grandibracteata* subsp. Parker Range (K. Newbey 9270). There are numerous collections of this taxon, which has a distribution c. 80 km long.

Variants. Southern specimens that were previously housed as *Baeckea grandibracteata* subsp. Parker Range (e.g. *N. Gibson & M. Lyons* 2085, *M. Hislop & J. Williams* MH 4167 and *K.R. Newbey* 9440) may have a slightly greater tendency to shed their bracteoles prior to fruit maturation than in typical *B. grandibracteatum*, but both variants have large, persistent bracteoles. Two specimens from the Mt Hampton area (e.g. *M.E. Trudgen* MET 23397 A), have a minute apical mucro on young leaves that is seldom present on other specimens.

Notes. This subspecies has straight, compressed peduncles that expand to be very broad distally and tend to have the same rugose-pitted patterning as the hypanthium (Figure 11). The basal stem was recorded as being 14 mm in diameter on *B.L. Rye & M.E. Trudgen* BLR 241065.

9b. *Balaustion grandibracteatum* subsp. *juncturum* Rye, subsp. nov.

Type: east of Forrestania crossroads, Western Australia [precise locality withheld for conservation reasons], 6 November 2004, *B.L. Rye & M.E. Trudgen* BLR 241187 (*holo*: PERTH 07218141; *iso*: CANB, K, MEL).

Baeckea sp. Blue Haze Mine (P. Armstrong 06/910), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Baeckea sp. Crossroads (B.L. Rye & M.E. Trudgen 241186), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Baeckea sp. Forrestania (K.R. Newbey 1105), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Petioles 0.3–0.6 mm long. *Leaf blades* 2–5 mm long, 0.8–1.1 mm wide, 0.5–0.7 mm thick. *Peduncles* 2–6 mm long. *Bracteoles* mostly shed prior to or at anthesis, 3–5.5 mm long. *Pedicels* 0–0.5(–0.7) mm long. *Sepals* 0.6–1.5(–1.7) mm long. *Stamens* 14–26. *Ovules* 12–20 per loculus. *Style* 1.6–2.3 mm long. (Figure 7B)

Diagnostic characters. Differs from the other subspecies by the combination of deciduous bracteoles 3–5.5 mm long and pedicels 0–0.5(–0.7) mm long.

Selected specimens examined. WESTERNAUSTRALIA: [localities withheld for conservation reasons] 10 Nov. 2005, *G.F. Craig* 7031 (PERTH); 10 Oct. 2018, *R. Davis & M. Hislop* 121948 (PERTH); 23 Oct. 1997, *T.D. Macfarlane* 2008 (PERTH); 14 Oct. 1963, *K.R. Newbey* 1105 (PERTH); 5 Nov. 2004, *B.L. Rye & M.E. Trudgen* BLR 241176 (PERTH); 12 Dec. 2008, *M.E. Trudgen* 23417 (PERTH).

Distribution and habitat. Extends from the Mt Holland area south to the Forrestania crossroads area (Figure 5), occurring in sandy soils, sometimes with lateritic gravel or granite cobbles, in shrublands commonly dominated by *Acacia*, *Allocasuarina* or *Eucalyptus* species.

Phenology. Flowers recorded in October and November.

Etymology. From the Latin *junctura* (join, junction) as this taxon has mainly been collected in the vicinity of the Forrestania crossroads.

Conservation status. To be listed as Priority Two under Conservation Codes for Western Australian Flora (Tanya Llorens pers. comm.). The synonyms *Baeckea* sp. Blue Haze Mine, *B. sp.* Crossroads (B.L. Rye & M.E. Trudgen 241186) and *B. sp.* Forrestania (K.R. Newbey 1105) are all currently listed as Priority One (Western Australian Herbarium 1998–).

Variation. Three phrase names have been applied to this subspecies but there are no clear morphological discontinuities between them. *Baeckea* sp. Forrestania and *B. sp.* Blue Haze Mine were applied to specimens with sepals 0.6–1 mm long, while *B. sp.* Crossroads was applied to specimens with short or long sepals (see population samples below). Sepal length is similarly variable in subsp. *grandibracteatum* but somewhat greater on average, having the range 0.8–2 mm long.

Where multiple specimens have been collected from the same population, sepal length, peduncle length and other characters can vary considerably. For example, both population samples of *Baeckea* sp. Crossroads (B.L. Rye & M.E. Trudgen BLR 241186–241189; M.E. Trudgen MET 23402) have sepals of very varied size (0.6–1.5 mm long) and shape. M.E. Trudgen 23359C has pedicels more or less absent whereas M.E. Trudgen 23359A from the same population has pedicels c. 0.7 mm long. This high degree of variation in sepal morphology within a population, or even on a single specimen, does not support recognition of additional subspecies let alone species among the central populations of the *Balaustion grandibracteatum* complex. However, the overall variation in subspecies *juncturum* needs further study in the field.

Stamen numbers are particularly variable in specimens collected in the Mt Holland area, ranging from 14 to 26.

Notes. A specimen (R.E. Sokolowski s.n. 19 Oct. 1988) of *Baeckea* sp. Blue Haze Mine has a flower bud with a distinct pedicel 2 mm long above a peduncle 5 mm long (with the bracteoles shed), but also has a flower with no pedicel and persistent bracteoles above a peduncle 5 mm long. The 2 mm long pedicel has not been included in the subspecies description as it appears to be an abnormality.

9c. *Balaustion grandibracteatum* subsp. *meridionale* Rye, subsp. nov.

Type: west of Kumarl, Western Australia [precise locality withheld for conservation reasons], 10 October 1966, P.G. Wilson 5717 (*holo:* PERTH 06748279; *iso:* K, MEL).

Baeckea sp. Mt Gibbs (G.F. Craig 7031), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Baeckea sp. Mt Glasse (P.G. Wilson 5717), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Petioles 0.3–0.6 mm long. *Leaf blades* 2.5–3.5 mm long, 0.8–1.1 mm wide, 0.5–0.7 mm thick, densely denticulate at first. *Peduncles* 2–3.5 mm long. *Bracteoles* mostly shed prior to anthesis, 2–3 mm long. *Pedicels* 0.7–1.5 mm long. *Sepals* 1.2–1.6 mm long. *Stamens* 18–23. *Ovules* 12–16 per loculus. *Style* 2–2.45 mm long.

Diagnostic characters. Differs from the other subspecies in having longer pedicels and shorter bracteoles.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 10 Nov. 2005, G.F. Craig 7031 (PERTH); 25 Oct. 1993, R. Heberle s.n. (PERTH); 14 Oct. 1978, D. Monk 444 (PERTH).

Distribution and habitat. Extends from the Mt Gibbs area in the west to beyond the eastern end of Frank Hann National Park (Figure 5), occurring in sandy soils, sometimes with lateritic gravel or granite cobbles, in shrublands commonly dominated by *Acacia*, *Allocasuarina* or *Eucalyptus* species.

Phenology. Flowers recorded in October and November.

Etymology. From the Latin *meridionalis* (southern) as this subspecies occurs south of the other subspecies and at the southern margin of the distribution of the genus.

Conservation status. To be listed as Priority Two under Conservation Codes for Western Australian Flora (Tanya Llorens pers. comm.). The synonyms *Baeckea* sp. Mt Glasse (P.G. Wilson 5717) and *B.* sp. Mt Gibbs (G.F. Craig 7031) are listed as Priority One and Two, respectively (Western Australian Herbarium 1998–).

Variation. Although two phrase names have been applied to this subspecies, only ten specimens are known and they show much less morphological variation than has been found amongst the specimens examined for each of the other two subspecies. All subsp. *meridionale* specimens have bracteoles 2–3 mm long and pedicels 0.7–1.5 mm long whereas all specimens of subspp. *grandibracteatum* and *juncturum* have bracteoles 3–6 mm long and pedicels 0–0.4(–0.7) mm long.

10. *Balaustion karroun* Rye, *sp. nov.*

Type: Bonnie Rock, 10 October 1984, Western Australia, *B.H. Smith 475* (*holo:* PERTH 06748414; *iso:* MEL 1527970 *n.v.*).

Baeckea sp. Wialki (G.M. Storr s.n. 4/10/1958), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Shrub 0.4–0.5 m high, *c.* 0.5 m wide; flowering branchlets with 1 pair of flowers. *Leaves* appressed to widely antrorse. *Petioles* 0.4–0.6 mm long. *Leaf blades* obovate, 2.5–3.7 mm long, 1.4–1.6 mm wide, not very thick, obtuse, entire or very minutely serrulate, slightly recurved at apex; abaxial surface keeled towards apex, the keel distally rounded, with the larger oil glands usually in 2 or 3 main rows on each side of midvein; adaxial surface shallowly concave (or shallowly indented), with less obvious oil glands. *Peduncles* 3–3.5 mm long, longitudinally finely ridged. *Bracteoles* enclosing the late buds, usually shed before the fruits mature, 4–6 mm long. *Pedicels* scarcely developed, less than 0.5 mm long. *Flowers* *c.* 15 mm diam. *Hypanthium* 2.5–3.5 mm long, 4–5 mm wide (increasing in fruit to a maximum of 4 × 5.5 mm), green and somewhat rugose in adnate part; free part *c.* 0.8 mm long, often reddish-tinged. *Sepals* broadly or very broadly ovate, 2–2.5 mm long, 3–4 mm wide, scarious, reddish outside with a whitish border 0.3–0.5 mm wide, ± entire. *Petals* *c.* 5 mm long, white. *Stamens* commonly 22–25. *Antipetalous filaments* *c.* 2.5 mm long. *Anthers* *c.* 0.5 mm wide from front view; connective gland 0.4–0.5 mm long; thecae *c.* 0.25 mm long. *Ovary* *c.* 1/2 inferior; ovules usually 20–22 per loculus. *Style* 2.7–3.1 mm long; stigma 0.2–0.3 mm diam. *Fruits* *c.* 2/3 inferior, 4–4.5 mm long, *c.* 6 mm diam.; placentas ovate, 2.5–2.9 × 1.4–1.6 mm. *Seeds* reniform but slightly faceted, 1.35–1.5 mm long, 0.55–0.65 mm wide, 0.6–0.7 mm thick, golden brown, minutely colliculate; inner cavity 0.5–0.8 mm long. (Figure 1F)

Diagnostic features. Distinguished from other species of *Balaustion* that have leaves with the keel distally rounded (not pointed or knobbed) in having the following combination of characters: obovate leaves 1.4–1.6 mm wide and large bracteoles that enclose the flowers in late bud.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 13 Oct. 2006, *A. Crawford & N. Sheehy* ADC 1175 (PERTH); 18 Nov. 1993, *H. Pringle* 30157 (PERTH); 4 Oct. 1958, *G.M. Storr s.n.* (PERTH); 18 Nov. 2008, *M.E. Trudgen* MET 23275 A (AD, BRI, PERTH); 18 Nov. 2008, *M.E. Trudgen* MET 23269 C (CANB, NSW, PERTH).

Distribution and habitat. Extends from Diemals Station south-west to near Wialki (Figure 9), growing in yellow sandy soils with scrub, and at one location with *Acacia* and *Eucalyptus leptopoda*.

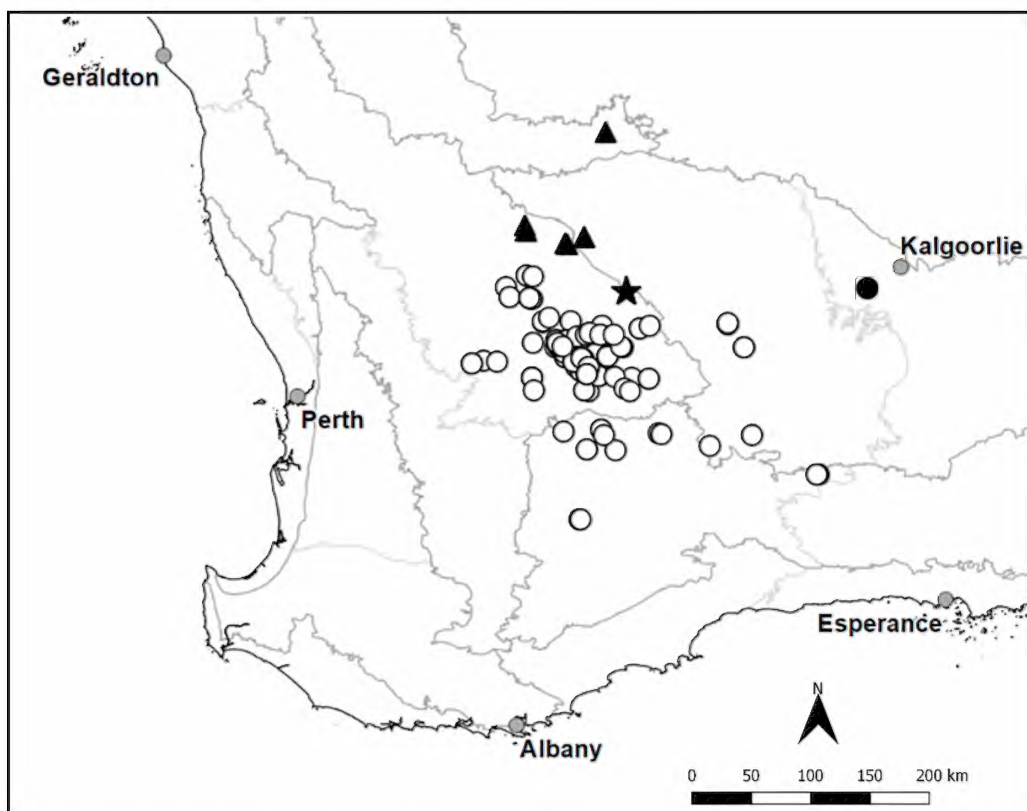


Figure 9. Distribution of *Balaustion karroun* (▲), *B. quinquelobum* confirmed (○) and unconfirmed localities (●), and *B. spenceri* (★).

Phenology. Flowers recorded in October and November and mature fruits in November.

Etymology. Named after the Karroun Hill Nature Reserve. The new species has been recorded both to the north-east and to the south of this very large reserve, with all its known localities less than 40 km from the reserve. The epithet is formed as a noun in apposition.

Conservation status. Listed as Priority One under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Baেকেa* sp. Wialki (G.M. Storr s.n. 4/10/1958). The geographic range recorded for *B. karroun* is about 135 km long, with most of the region between the north-eastern and southern localities being very poorly explored botanically, so additional localities are likely to be discovered for this species with targeted survey.

Affinities. This species is similar to *B. grandibracteatum* in having bracteoles up to 6 mm long but its bracteoles are less persistent. It is more like *B. baiocalyx* in its flattened leaves and long style but is readily distinguished by its larger sepals and bracteoles. It also shows some similarities to *B. thamnoides* (see details under that species).

Notes. There is limited good flowering material of this species, reducing the reliability of the above description of floral characters, such as ovule numbers.

11. *Balaustion mukinbudin* Rye, *sp. nov.*

Type: north-east of Mukinbudin, Western Australia [precise locality withheld for conservation reasons], 15 October 2005, *M. Hislop & F. Hort* MH 3528 (*holo:* PERTH 07421486; *iso:* CANB, K, MEL, NSW).

Baeckea sp. Elsewhere Road (M.E. Trudgen 5420), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Shrub 0.2–0.8 m high, 0.3–1 m wide; flowering branchlets with 1 pair of flowers or more commonly just a solitary flower. *Leaves* appressed to widely antrorse. *Petioles* 0.3–0.5 mm long. *Leaf blades* narrowly to broadly obovate, 2–4 mm long, (1–)1.2–1.6(–1.8) mm wide, *c.* 0.4–0.5 mm thick, obtuse, not mucronate or with a mucro less than 0.1 mm long, denticulate at first, slightly recurved at apex; abaxial surface prominently and rather narrowly keeled towards apex and produced into a ridge or slight subterminal point (the apex then appearing double-pointed), with the larger oil glands usually in 2 or 3 main rows on each side of midvein; adaxial surface shallowly concave (or shallowly indented), with less obvious oil glands. *Peduncles* 2.5–4 mm long. *Bracteoles* enclosing the late buds, scarious, often persistent on young fruits, 4–5.5 mm long. *Pedicels* ± absent. *Flowers* 11–16 mm diam. *Hypanthium* 2–2.7 mm long, *c.* 5 mm wide, green and minutely but distinctly rugose in adnate part; free part *c.* 0.6 mm long, often reddish-tinged. *Sepals* depressed ovate-elliptic to somewhat more triangular, 1.4–2.5 mm long, 2.5–3.5 mm wide, reddish with whitish irregular margins not forming a definite border or with a definite whitish border up to *c.* 0.4 mm wide, margin minutely laciniate. *Petals* 4–6.5 mm long, white. *Stamens* 19–25. *Antipetalous filaments* 1.8–2.4 mm long. *Anthers* *c.* 0.6 mm wide from front view; connective gland *c.* 0.8 mm long; thecae *c.* 0.25 mm long. *Ovary* *c.* 1/2 inferior; ovules 13–18(–20) per loculus. *Style* 1.9–2.5 mm long; stigma 0.2–0.25 mm diam. *Fruits* *c.* 2/3 superior, *c.* 4 mm long, *c.* 5 mm diam.; placentas elliptic or ovate, *c.* 2.6 × 1.6 mm. *Seeds* reniform but somewhat faceted, 1.2–1.35 mm long, 0.5–0.65 mm wide, 0.6–0.7 mm thick, golden brown, minutely colliculate; inner cavity 0.7–0.75 mm long. (Figure 1C, H, J & K)

Diagnostic features. Distinguished from other species of *Balaustion* that have a 2-pointed apex to the leaves in having scarious, persistent bracteoles 4–5.5 mm long and pedicels ± absent.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 28 Oct. 1999, *M. Buist s.n.* (PERTH); 24 Sep. 2016, *G. Byrne* 6050 (PERTH); 14 Oct. 2006, *A. Crawford* ADC 1183 (PERTH); 22 Sep. 1982, *K.R. Newbey* 9576 (CANB *n.v.*, PERTH); 16 Oct. 1978, *P. de Rebeira* 15 (PERTH); 10 Oct. 1988, *B.H. Smith* 1102 (BRI *n.v.*, CBG *n.v.*, HO *n.v.*, MEL *n.v.*, PERTH); 14 Nov. 1986, *M.E. Trudgen* 5420 (AD, MEL, NSW, PERTH), 2 Dec. 2008, *M.E. Trudgen* MET 23340 A, B (PERTH); 30 Sep. 1984, *A.S. Weston* 14131 (PERTH).

Distribution and habitat. Extends from east of Bonnie Rock south to Chiddarcooping Nature Reserve (Figure 10), occurring in yellow sand, at least sometimes with *Melaleuca*, and at one locality recorded with *Baeckea elderiana*.

Phenology. Flowers from September to November, with copious nectar observed. Mature fruits were recorded in November.

Etymology. Named after the town of Mukinbudin, which is a centre for the occurrence of *Balaustion*, with seven additional taxa recorded in or near the Shire of Mukinbudin: *B. bimucronatum*, *B. exsertum*,

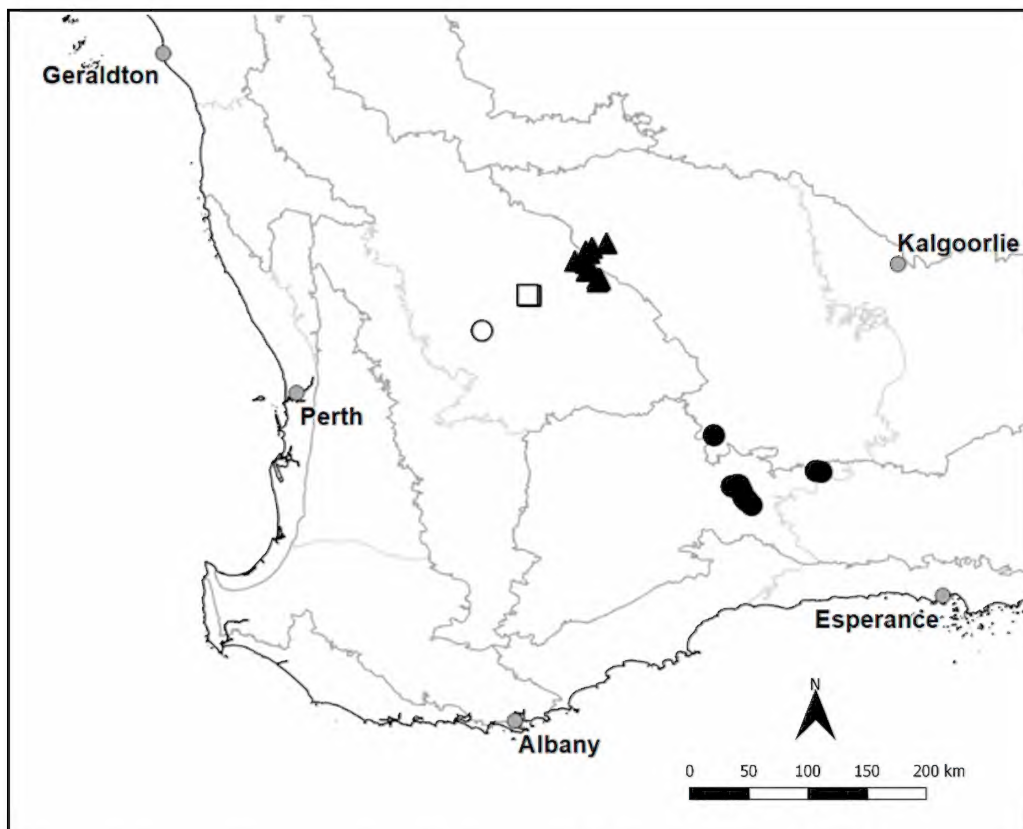


Figure 10. Distribution of *Balaustion muginbudin* (▲), *B. thamnoides* (●), *B. sp. Billyacatting* (□) and *B. sp. Yorkrakine* (○).

B. filifolium, *B. interruptum*, *B. karroun*, *B. pulcherrimum* and *B. quinquelobum*. The epithet is formed as a noun in apposition.

Conservation status. Listed as Priority Three under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Baeckea* sp. Elsewhere Road (M.E. Trudgen 5420). *Balaustion muginbudin* is a geographically restricted species, its known range less than 40 km long and c. 30 km wide.

Affinities. *Balaustion muginbudin* is similar to *B. grandibracteatum* in having large bracteoles clasping the base of its flowers and fruits (Figure 1J), but *B. grandibracteatum* differs in having narrower, thicker leaves with a rounded keel. Its closest relative might be *B. bimucronatum*, which occurs just to the south but has shorter, less persistent bracteoles, shorter sepals and a longer style (see Table 2).

Notes. The style of *B. muginbudin* is quite short in comparison with the taxa that appear to be close relatives (see Table 2) but similar-sized or shorter styles are found within the *B. grandibracteatum* complex and in *B. quinquelobum*.

12. *Balaustion multicaule* Rye, *sp. nov.*

Type: Mount Holland Track, Western Australia [precise locality withheld for conservation reasons], 5 November 2004, *B.L. Rye & M.E. Trudgen* BLR 241168 (*holo*: PERTH 09447164; *iso*: CANB, K, MEL, PERTH 07218532).

Baeckea sp. Sheoaks Rocks (M.E. Trudgen MET 5452), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Shrub 0.15–0.3 m high, with many slender stems from a woody base; flowering branchlets usually with 1 pair of flowers. *Leaves* almost appressed to widely antrorse. *Petioles* *c.* 0.4 mm long. *Leaf blades* narrowly ovate to very narrowly obovate or linear in outline, *c.* 3 mm long, 0.5–0.7 mm wide, 0.4–0.5 mm thick, obtuse, with denticulate margins at first, becoming entire; abaxial surface deeply convex, with the larger oil glands usually in 1 or 2 main rows on each side of midvein; adaxial surface shallowly concave (or shallowly indented), with less obvious oil glands. *Peduncles* 3–5 mm long. *Bracteoles* sometimes persistent on the mature fruits, 2–3 mm long. *Pedicels* *c.* 1 mm long. *Flowers* 10–11 mm diam. *Hypanthium* 1.7–2.3 mm long, 3–4.5 mm diam., green; free part *c.* 0.6 mm long. *Sepals* depressed ovate, *c.* 1 mm long, *c.* 1.6 mm wide, red, almost entire. *Petals* *c.* 4 mm long, pale pink. *Stamens* 18–20. *Antipetalous filaments* *c.* 1.6 mm long. *Anthers* *c.* 0.4 mm wide from front view; connective gland *c.* 0.4 mm long; thecae *c.* 0.25 mm long. *Ovary* *c.* 1/2 inferior; ovules 11–16 per loculus. *Style* *c.* 2 mm long, exerted part red, with basal 0.6 mm enclosed and green; stigma 0.15–0.2 mm diam. *Fruits* *c.* 2/3 superior, 3–3.5 mm long, 4–5 mm diam.; placentas elliptic-ovate, 1.6–1.8 × 1–1.3 mm. *Seeds* faceted-reniform, 1.4–1.6 mm long, 0.6–0.7 mm wide, 0.7–0.8 mm thick, medium to dark brown, minutely colliculate, the colliculae not as deep on outer surface as on lateral surfaces; inner cavity 0.8–1 mm long. *Chaff pieces* golden-brown, distinctly paler than seeds.

Diagnostic features. Distinguished from other species of sect. *Tilophloia* by the combination of its multi-stemmed habit, small bracteoles and narrow, thick leaves with the keel rounded at the apex (not pointed or knobbed).

Selected specimens examined. WESTERNAUSTRALIA: [localities withheld for conservation reasons] 5 Nov. 2004, *B.L. Rye & M.E. Trudgen* BLR 241166 (AD, PERTH); 21 Nov. 1986, *M.E. Trudgen* MET 5452 (AD, MEL, PERTH).

Distribution and habitat. Known from a single locality in the Sheoak Rock area, east of Hyden (Figure 6), where it grows in pale yellow-brown sand with scattered mallees over Myrtaceae and Proteaceae heath.

Phenology. Flowers in October and November. Fruits recorded in late November.

Etymology. From the Latin *multus* (many) and *caulis* (stem), referring to the multi-stemmed habit.

Conservation status. Listed as Priority One under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Baeckea* sp. Sheoaks Rocks (M.E. Trudgen MET 5452). Known from only two, very close localities.

Affinities. This is a member of the *B. grandibracteatum* complex. It can be distinguished from

B. grandibracteatum by its multi-stemmed habit and narrower leaves (0.5–0.7 mm *cf.* 0.7–1(–1.5) mm wide).

Notes. The description of the flowers of *B. multicaule* is based on very little material, resulting in little or no range of measurements for each organ. *Balaustion multicaule* (B.L. Rye & M.E. Trudgen BLR 241168) has been recorded growing with *B. pulcherrimum* (B.L. Rye & M.E. Trudgen BLR 241169) at the type locality.

13. *Balaustion polyandrum* Rye, *sp. nov.*

Type: Jaurdi Station, Western Australia [precise locality withheld for conservation reasons], 12 October 1999, L.W. Sage & F. Hort 2229 (*holo:* PERTH 06202446; *iso:* CANB, K).

Baeckea sp. Jaurdi Station (L.W. Sage & F. Hort 2229), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Shrub *c.* 0.5 m high, width unknown; flowering branchlets with 1 pair of flowers. *Leaves* mostly widely antrorse. *Petioles* 0.4–0.5 mm long. *Leaf blades* commonly obovate, 3–4 mm long, 1.2–1.5 mm wide, not very thick, obtuse, denticulate; abaxial surface prominently and rather narrowly keeled towards apex and frequently produced into a ridge or slight subterminal point (the apex often appearing double-pointed), with the larger oil glands usually in 1 or 2 main rows on each side of midvein; adaxial surface shallowly concave (or shallowly indented), with less obvious oil glands. *Peduncles* 3–4 mm long. *Bracteoles* shed from young buds, *c.* 2 mm long. *Pedicels* usually 0.5–1 mm long. *Flowers* 15–17 mm diam. *Hypanthium* 3–4 mm long, 5–6 mm wide, green and somewhat rugose throughout; free part *c.* 1 mm long. *Sepals* depressed ovate, 0.8–1 mm long, *c.* 3 mm wide, deep red outside with a whitish border *c.* 0.2 mm wide, minutely denticulate. *Petals* 6–7 mm long, white. *Stamens* *c.* 30. *Antipetalous filaments* *c.* 2.5 mm long. *Anthers* *c.* 0.5 mm wide from front view; connective gland *c.* 0.6 mm long; thecae *c.* 0.3 mm long. *Ovary* *c.* 2/3 inferior; ovules 20–22 per loculus. *Style* *c.* 4 mm long; stigma *c.* 0.25 mm diam. *Fruits* not seen at maturity. (Figure 1D)

Diagnostic characters. Distinguished from other species of *Balaustion* that have a dorsal point or knob and sometimes 2-pointed apex to the leaves by the following combination of characters: bracteoles caducous, *c.* 2 mm long; sepals very reduced, 0.8–1 mm long; stamens *c.* 30; ovules 20–22 per loculus.

Distribution and habitat. Recorded from Jaurdi Station, east of Koolyanobbing (Figure 8), in yellowish sand with *Eucalyptus* low woodland and *Acacia* heath.

Phenology. Flowers recorded in October.

Etymology. From the Greek *poly-* (many-) and *-andrus* (male), referring to the numerous stamens. Judging from its single collection, this species has the highest stamen number, on average, in sect. *Tilophloia*.

Conservation status. Listed as Priority One under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Baeckea* sp. Jaurdi Station (L.W. Sage & F. Hort 2229). Known from only one collection.

Affinities. This species keys out with the fairly numerous species that have leaves with the apex often appearing double-pointed, such as *B. spenceri*, which differs in its longer pedicels and smaller flowers, and *B. mukinbudin*, which is distinguished by its longer sepals and large, persistent bracteoles. It is also similar to *B. baiocalyx* in being large-flowered and having reduced sepals but differs as discussed under that species, including by its usually 2-pointed leaves.

Notes. In *B. polyandrum*, the pedicels are 0.5–1 mm long and much shorter than the 3–4 mm long peduncles. In contrast, pedicels are up to 4 mm long and usually greater in relation to the peduncles, sometimes exceeding the peduncles in length, in most of the subsequently keyed species (choices 16–20).

Only one flower bud was dissected; it had 30 stamens and one staminode, giving a total of 31 filaments, and 20, 21 and 22 ovules respectively in the three loculi, giving a total of 63 ovules in the ovary. The oldest fruit present was still c. 2/3 inferior, 4.5–5 mm long and c. 6 mm diam. A lack of mature fruits renders the description incomplete.

14. *Balaustion quinquelobum* Rye, *sp. nov.*

Type: 106 km west of Southern Cross, Western Australia, 20 September 1978, R.J. Cranfield 601 (*holo:* PERTH 09447172; *iso:* AD, BRI, CANB, HO, K, MEL, NSW, PERTH 03416356).

Baeckea rosea Trudgen ms., in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 348 (2000), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Baeckea sp. Koonadgin (B.L. Rye & M.E. Trudgen BLR 241137), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Baeckea sp. Muntadgin (E.T. Bailey 231), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

[*Baeckea grandis* var. *exserta* (S.Moore) C.A.Gardner ms, *in sched.* (PERTH 09116400). Misapplied with respect to current circumscription of *Balaustion exsertum*.]

Shrub low-growing to fairly erect, 0.15–0.8 m high, 0.2–1.4 m wide, sometimes multi-stemmed; flowering branchlets with 1(2) pairs of flowers. *Leaves* closely antrorse to almost patent. *Petioles* 0.2–0.4 mm long. *Leaf blades* narrowly ovate or narrowly oblong to linear in outline, often broadest at the base at maturity, 2–3(–4) mm long, 0.5–0.7 mm wide, 0.4–0.6 mm thick, minutely denticulate at first (sometimes very sparsely), often becoming entire, with a subterminal, dorsal knob or mucro, sometimes also with a minute terminal mucro less than 0.1 mm long; abaxial surface keeled towards apex and narrowly furrowed below, the keel prominent just below the apex and tending to form a subterminal point, with the larger oil glands in 1–3 (usually 1 or 2) main rows on each side of midvein; adaxial surface slightly convex to flat, often with a narrow furrow along the centre, with less obvious oil glands. *Peduncles* 1.5–2.5 mm long. *Bracteoles* borne well below the mature buds, widely antrorse to patent, usually persistent, 1.3–2.5 mm long, narrowly keeled almost to apex. *Pedicels* (1–)1.3–2.5 mm long. *Flowers* 10–14 mm diam. *Hypanthium* with 5 lobes surrounding and extending somewhat below (rarely level with) the apex of the pedicel, 1–1.5 mm long, 2.5–3.5 mm wide, rugose-pitted; free part 0–0.4 mm long. *Sepals* broadly ovate, 1.5–2 mm long, 2.3–2.8 mm wide, scarious, reddish outside within a broad pale border or with scarcely any pale border (often with reddish parts irregularly extending

into the broad pale border), minutely serrulate to laciniate. *Petals* 3.5–6 mm long, white or pale pink. *Stamens* 18–25. *Antipetalous filaments* 1.3–2 mm long. *Anthers* 0.3–0.35 mm wide from front view; connective gland 0.35–0.5 mm long, pink; thecae 0.2–0.3 mm long, brownish. *Ovary* c. 1/2 inferior; ovules (8–)10–15 per loculus. *Style* 1.4–2.2 mm long; stigma c. 0.1 mm diam. *Fruits* c. 2/3 superior, 2.2–2.7 mm long, 3–4 mm diam.; placentas elliptic, 1.7–2.5 × 1.1–1.3 mm. *Seeds* faceted-reniform, 1.2–1.5 mm long, 0.6–0.75 mm wide, 0.6–0.7 mm thick, golden brown, minutely colliculate; inner cavity 0.7–0.8 mm long.

Diagnostic features. The most distinctive feature is the 5-lobed hypanthium, with the lobes usually projecting down below the summit of the pedicel. Other important characters: bracteoles borne well below the mature buds, 1.3–2.5 mm long, persistent; antipetalous filaments 1.3–2 mm long; style 1.4–2.2 mm long; ovules 8–15 per loculus.

Selected specimens examined. WESTERN AUSTRALIA: Karalee Rock, 8 Oct. 2018, *R. Davis & M. Hislop* 12926 (PERTH); adjacent to Great Eastern Hwy, 2.75 km W of Burracoppin, Dec. 2004, *N. Everidge s.n.* (CANB, PERTH); on W side of Roberts Rd, c. 1 km S of Nangeenan North Rd, Nature Reserve 11522, c. 9 km SE of Nungarin, 29 Aug. 1999, *G.J. Keighery & N. Gibson* 3012 (PERTH); SWATT Sandplain Survey, UCL (Unallocated Crown Land), survey site SWA0404D, c. 61.09 km N (6.99 degrees) of Hyden and c. 55.04 km WNW (70.89 degrees) of Narembene, 14 Oct. 2013, *R. Meissner & B. Bayliss* 5728 (PERTH); W of Moorine Rock, toward Nulla Nulla, 10 Sep. 1968, *M.E. Phillips* WA 68/753 (CBG, PERTH); Roe Rd, 1.8 km N of Billericay Rd, NW of Hyden, 4 Nov. 2004, *B.L. Rye & M.E. Trudgen* BLR 241157 (PERTH); 18.9 km E of Yellowdine on Great Eastern Hwy, 6 Nov. 2004, *B.L. Rye & M.E. Trudgen* BLR 241197 (BRI, PERTH); c. 3–5 km E of Merredin along Great Eastern Hwy, 29 Sep. 1981, *R. Spjut, G. White, R. Phillips & L. Lacy* 7231 (PERTH); Quadrat T33-15. NW of Hyden on northern boundary of Roe Nature Reserve, 6 Oct. 2003, *A. Waters* 187 (PERTH); Great Eastern Hwy near Walgoorlan (± 20 miles E of Merredin), 18 Sep. 1963, *J.H. Willis s.n.* (MEL *n.v.*, PERTH); 19.7 km E of Yellowdine, 15 Oct. 1997, *Peter G. Wilson & N. Lam* PGW 1384 (NSW *n.v.*, PERTH, UNSW *n.v.*).

Distribution and habitat. Extends mainly from Welbungin south to Lake Grace and to east of Lake King (Figure 9), occurring in varied vegetation on yellow sand or other kinds of sandy soils, sometimes over laterite or with lateritic gravel. *Balaustion quinquelobum* has often been recorded co-occurring with *Baeckea muricata*. There is one isolated, unconfirmed locality (Figure 9) of ‘Coolgardie’ on *B.A. Rockel* U (PERTH 03378276 & 04532856).

Phenology. Flowers recorded from August to November but mainly in September and October. Mature fruits recorded from October to January.

Etymology. From the Latin *quinque*- (five-) and *lobus* (lobe), referring to the hypanthium being 5-lobed where it is attached to the pedicel.

Conservation status. There are numerous collections of this species, which has a distribution c. 300 km long. No conservation code is required (Tanya Llorens pers. comm.). Note that *Baeckea* sp. Muntadgin (E.T. Bailey 231) was previously listed as Priority One under Conservation Codes for Western Australian Flora.

Affinities. Similar to *B. exsertum*, *B. filifolium* and *B. spenceri* but differing from all of them in its usually shorter hypanthium with more obvious lobes, shorter stamens and shorter style. See notes under those taxa. All four species have very similar flower diameters and petal lengths.

Variants. Inland specimens, such as those from the Yellowdine area, tend to be small-leaved and small-flowered, including one used as the basis for the name *B. sp.* Muntagin (E.T. Bailey 231), which has leaves about 2 mm long and petals about 3.5 mm long. However, small-leaved and small-flowered specimens are also found scattered throughout the range of the species and there is no clear separation between them and specimens with longer leaves and petals, so this variant does not appear to be sufficiently distinctive to recognise formally.

Notes. Gardner noted on a Tammin specimen that he collected in September 1936 (PERTH 06115144) that *Baeckea exserta* may just be a variety of *B. grandis* and later applied the manuscript name *B. grandis* var. *exserta* to a duplicate (PERTH 09116400), both sheets of which have subsequently been identified as *B. quinquelobum*. There is also a collection of *B. exsertum* with the same date (*C.A. Gardner s.n.* PERTH 03350991) from ‘Tammin district’ (rather than just Tammin). Whether the two species co-occurred at a single locality or were collected from two different localities in that month is uncertain, but this is the only case where Tammin is recorded as the locality for *B. quinquelobum* and it is the westernmost locality recorded for that species, although only by a relatively short distance.

Baeckea sp. Koonadgin (B.L. Rye & M.E. Trudgen BLR 241137) was established to replace the manuscript name *B. rosea* Trudgen. On some early collections, the flower colour was recorded as pink or ‘rose pink’, which apparently explains the choice of the manuscript name *Baeckea rosea* for this species. Recent collections record flower colour as white or pale pink, but buds are commonly deep pink in colour, with the outer petals retaining deep pink patches on their outer surface after anthesis.

Some specimens are multi-stemmed at ground level but in some cases this is because the base of the plant has been buried. The species is usually not lignotuberosus but further survey is needed to determine whether some populations or individual plants can produce a lignotuber.

15. *Balaustion spenceri* Rye, *sp. nov.*

Type: near Baladjie, Western Australia [precise locality withheld for conservation reasons], 14 October 2004, *B.L. Rye & M.E. Trudgen* BLR 241060 (*holo:* PERTH 07264550; *iso:* CANB, K, MEL, NSW).

Baeckea sp. Baladjie (P.J. Spencer 24), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Shrub forming a low dome 0.2–0.3 m high, 0.5–0.9 m wide; flowering branchlets with 1 pair of flowers or more commonly just a solitary flower. *Leaves* appressed to patent, commonly antrorse. *Petioles* 0.4–0.5 mm long. *Leaf blades* ovate to narrowly obovate or narrowly elliptic, 3–3.5 mm long, 0.6–1.1 mm wide, not very thick, obtuse or acute and with a mucro less than 0.1 mm long, minutely denticulate at first, becoming entire, slightly recurved at apex; abaxial surface prominently and rather narrowly keeled towards apex and produced into a ridge or slight subterminal point (the apex often appearing double-pointed), with the larger oil glands usually in 1 or 2 main rows on each side of midvein; adaxial surface shallowly concave (or shallowly indented), with less obvious oil glands. *Peduncles* 1–2.5 mm long. *Bracteoles* widely antrorse and well below the older buds, shed prior to anthesis, 1.3–1.6 mm long. *Pedicels* 2–3.5 mm long. *Flowers* 8.5–11 mm diam. *Hypanthium* obconic, 1.5–2 mm long, 3–4 mm wide, green and somewhat rugose in adnate part; free part *c.* 0.7 mm long, deep reddish. *Sepals* broadly to depressed ovate, 0.8–1.5 mm long, 1.7–2.3 mm wide, deep red with a whitish border *c.* 0.3 mm wide, minutely denticulate. *Petals* 3.5–5 mm long, white. *Stamens* 20–24, the broadest ones up to 0.6 mm wide at base. *Antipetalous filaments* 2–3.3 mm long. *Anthers* *c.* 0.4 mm wide

from front view; connective gland 0.3–0.35 mm long; thecae 0.25–0.3 mm long. *Ovary* c. 1/2 inferior; ovules 10–13 per loculus. *Style* 2.6–3.3 mm long; stigma c. 0.2 mm diam. *Fruits* not seen at maturity.

Diagnostic features. Distinguished from other species of *Balaustion* that have a 2-pointed apex to the leaves by the following combination of characters: leaves flattened; bracteoles shed early or borne well below mature buds, 1.3–1.6 mm long; hypanthium obconic; pedicels \pm equalling to much longer than the peduncles; antipetalous filaments 2–3.3 mm long; ovules 10–13 per loculus.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 14 Oct. 2004, B.L. Rye & M.E. Trudgen BLR 241061 (AD, PERTH); 14 Oct. 2004, B.L. Rye & M.E. Trudgen BLR 241062 (BRI, PERTH); 13 June 1995, P.J. Spencer 24 (CANB n.v., PERTH); 2 Dec. 2008, M.E. Trudgen MET 23350 A (PERTH).

Distribution and habitat. Recorded from between Warralakin and Bullfinch (Figure 9), in brown loam with some large quartz sand grains, probably with granite not far below the surface. The vegetation is recorded as *Acacia* high open shrubland, over *Malleostemon* shrubland over *Balaustion* low open shrubland over *Borya* herbland.

Phenology. Flowers recorded in June and October.

Etymology. Named after its first collector, Phillip J. Spencer (1964–), who was a technical officer at the Western Australian Herbarium for many years and is now a volunteer at the herbarium. The new species was amongst 40 specimens that he collected from the central wheatbelt in March and June 1995, at a time of year when relatively few species would have been in flower.

Conservation status. Listed as Priority One under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Baeckea* sp. Baladjie (P.J. Spencer 24). Only one population is known.

Affinities. This taxon is similar to *B. exsertum* but has flatter leaves, usually a more basally tapering (obconic) hypanthium and a greater tendency for the bracteoles to be shed early. It occurs about 75 km east of the closest known locality for *B. exsertum*, which is at the far north of *B. exsertum*'s distribution. Several other related taxa have closer populations. *Balaustion quinquelobum* occurs just south of *B. spenceri* and differs in its shorter style and 5-lobed hypanthium, while *B. filifolium* occurs less than 50 km to the north-east and has thicker leaves with a shorter petiole. Both *B. bimucronatum* and *B. mukinbudin* occur just to the west and differ in having larger bracteoles.

As discussed under *B. bimucronatum*, the apparent differences (see Table 2) between that species and *B. spenceri* might be an illusion resulting from the paucity of collections of both taxa and it might be more appropriate to treat them as subspecies.

Notes. This poorly known taxon has only been collected in flower on two occasions and has never been collected in mature fruit. The original collection made in June 1995 has large flowers in comparison with three specimens collected in October 2004. One flower dissected from B.L. Rye & M.E. Trudgen BLR 241060 is abnormal in having two loculi and placentas united, the total number ovules being 26, while the other loculus has 12 ovules.

16. *Balaustion tangerinum* Rye, *sp. nov.*

Type: Diemals, Western Australia [precise locality withheld for conservation reasons], 5 September 1999, A.P. Brown 3636 (*holo*: PERTH 07512600).

Baeckea sp. Diemals (A.P. Brown 3636), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Shrub height and width not recorded; flowering branchlets with 1 or 2 flowers. *Leaves* almost appressed to widely antrorse. *Petioles* 0.5–0.7 mm long. *Leaf blades* oblong or obovate, 3.5–4.5 mm long, 1.5–1.6 mm wide, not very thick, shallowly obtuse or truncate, ciliolate, often somewhat recurved at the apex; abaxial surface keeled towards apex, the keel rounded and thickened distally, sometimes appearing to be a slight subterminal swelling, with the larger oil glands usually in 2 or 3 main rows on each side of midvein; adaxial surface flat (at least for most of its length), with less obvious oil glands. *Peduncles* 3–4 mm long. *Bracteoles* usually persistent in fruit, *c.* 2.5 mm long, denticulate. *Pedicels* absent. *Flowers* 20–25 mm diam. *Hypanthium* 3–4 mm long, 6–8 mm wide, somewhat rugose, broad and hollowed at base, variously green-orange to reddish, not identical in colour to the petals; free part *c.* 1.5–2 mm long. *Sepals* \pm depressed ovate, *c.* 3 mm long, 4–5.5 mm wide, usually green with a whitish or pink-tinged border 0.3–0.5 mm wide, denticulate. *Petals* 9–10 mm long, orange, denticulate. *Stamens* *c.* 24. *Antipetalous filaments* *c.* 8 mm long. *Anthers* *c.* 0.5–0.6 mm wide from front view; connective gland 0.4–0.5 mm long; thecae *c.* 0.35 mm long. *Ovary* *c.* 1/2 inferior; ovules *c.* 20 per loculus. *Style* 11–12 mm long; stigma 0.2–0.3 mm diam. *Fruits* largely superior but not seen at maturity.

Diagnostic features. Distinguished from other species of *Balaustion* by having a hypanthium 3–4 mm long by 6–8 mm wide. Other important characters: sepals two-toned; petals orange, 9–10 mm long; style 11–12 mm long.

Distribution and habitat. Known from a single collection from the Diemals area (Figure 3). The habitat was not recorded but is likely to be sandplain.

Phenology. Flowers recorded in early September.

Etymology. From the Latin *tangerinus* (orange), referring to the orange colour of the petals.

Conservation status. Recently listed as Priority One under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Baeckea* sp. Diemals (A.P. Brown 3636). This taxon is known from only one collection and an attempt to recollect it at its type locality failed.

Affinities. Since *B. tangerinum* is known from just one collection and is unusual in having large, orange petals with a denticulate margin, the possibility that it is a hybrid between the orange-flowered *B. pulcherrimum* and a white-flowered species must be considered. *Balaustion karroun*, a white-flowered species that has been recorded from Diemals Station, was thought to be a candidate but has been excluded primarily on the basis of its leaf morphology. The combination of its thickened leaves, with no protrusion on the keel distally, and the leaf morphology found in *B. pulcherrimum*, cannot account for the broad, truncate, thin leaves of *B. tangerinum*. In terms of leaf morphology, *B. unguiculatum* is the only white-flowered species to look feasible as a parent species. *Balaustion tangerinum* is intermediate between *B. pulcherrimum* and *B. unguiculatum* in some respects but matches one or other of the putative parent species in others (Table 3). Although neither of the two possible

parent species has been collected from Diemals Station to date (Figure 2B), *B. pulcherrimum* has been observed there (A. Brown pers. comm.). *Balaustion unguiculatum* is currently known from three collections made about 80 km or more to the south of the single recorded location for *B. tangerinum*.

Overall, *B. tangerinum* shows greater similarity to members of sect. *Tilophloia* than to sect. *Balaustion* and hence is included in the former section. Its petals appear to be the longest in the genus; being up to 10 mm long, they just slightly exceed the maximum petal length recorded in *B. pulcherrimum*.

Notes. The Diemals Station area is poorly explored botanically. Surveys are needed to attempt to locate both previously recorded and additional populations in the region to determine how many *Balaustion* species occur there, investigate their conservation status, and assess whether *B. tangerinum* should be treated as a hybrid. A comparison of molecular sequences of *B. tangerinum* and any possible parent species should be very useful.

To protect the limited herbarium material of *B. tangerinum*, only one flower was dissected; it had 24 stamens, a style 11.5 mm long, and 18, 20 and 20 ovules in the three loculi, giving a total ovule number of 58.

Table 3. Comparison of *Balaustion tangerinum* with two possible parent species.

| Species | <i>B. pulcherrimum</i> | <i>B. tangerinum</i> | <i>B. unguiculatum</i> |
|-------------------|---------------------------|--------------------------|--------------------------|
| Stems fibres | not very abundant | abundant | abundant |
| Petiole length | 0.3–0.6 mm | 0.5–0.7 mm | 0.5–0.6 mm |
| Leaf shape | ovate to narrowly obovate | oblong or obovate | obovate to ± circular- |
| length | 2.7–6 mm | 3.5–4.5 mm | cordate |
| width | 1.2–1.5 mm | 1.5–1.6 mm | 2–3.5 mm |
| apex shape | acute | obtuse to truncate | 1.2–1.6 mm |
| muero | 0.15–0.3 mm long | absent | obtuse to truncate |
| | | | absent |
| Peduncle length | 2–4 mm | 3–4 mm | 2–3 mm |
| Pedicel length | 0–1 mm, usually ± absent | 0–0.3 mm | 1–3 mm |
| Hypanthium length | 9–20 mm | 3–4 mm | 2–2.5 mm |
| width | 6–8 mm | 6–8 mm | c. 4 mm |
| colour | identical to petals | not matching petals | not matching petals |
| Sepal length | 2.5–4 mm | c. 3 mm | 1.3–1.6 mm |
| border | obscure | obvious | obvious |
| Petal length | 7–9 mm | 9–10 mm | 4.5–5.5 mm |
| colour | orange | orange | white |
| margin | lacinate-denticulate | denticulate | almost entire |
| Stamen end | erect | directed inwards | directed inwards |
| filament length | 6.5–11 mm | c. 8 mm | 2–2.4 mm |
| length of thecae | 0.55–0.9 mm | c. 0.35 mm | 0.35–0.4 mm |
| slits | parallel | mostly divergent at base | mostly divergent at base |
| Style length | 20–24 mm | 11–12 mm | c. 3.5 mm |
| stigma width | 0.4–0.8 mm | 0.2–0.3 mm | 0.2–0.3 mm |

17. *Balaustion thamnoides* Rye, *sp. nov.*

Type: north-east of Lake King, Western Australia [precise locality withheld for conservation reasons], 13 November 1979, K.R. Newbey 6552 (*holo:* PERTH 06748236; *iso:* PERTH 06206077).

Baeckea sp. Hatter Hill (K.R. Newbey 3284), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Shrub 0.7–1.2 m high, commonly 0.4–0.6 m wide; flowering branchlets with 1 or 2 fertile nodes, each with 1 or 2 flowers. *Leaves* widely antrorse to appressed. *Petioles* 0.6–0.8 mm long. *Leaf blades* mostly narrowly elliptic, 3–5.5 mm long, 1.1–1.4 mm wide, up to c. 0.4 mm thick, obtuse, denticulate on scarious margins, slightly recurved at apex; abaxial surface with a poorly defined, rounded ‘keel’ gently to deeply curved down to the apex, with the larger oil glands usually in 2 or 3 main rows on each side of midvein; adaxial surface shallowly concave or flat, with less obvious oil glands. *Peduncles* 3–5 mm long. *Bracteoles* usually shed from medium-sized buds, 3.5–4.5 mm long. *Pedicels* 0.3–1 mm long. *Flowers* 13–17 mm diam. *Hypanthium* 2.5–4 mm long, 5–6 mm wide (somewhat increasing in fruit to a maximum of 4.5 mm long), green with surface tending to be rugose-wrinkled; free part c. 0.8 mm long, often reddish-tinged. *Sepals* depressed ovate, 1.2–2 mm long, 3–3.5 mm wide, partially reddish on outer surface and with an irregular white border 0.15–0.3 mm wide or \pm fully reddish, \pm entire or ciliolate. *Petals* 4.5–6.5 mm long, white or pale pink. *Stamens* 19–28. *Antipetalous filaments* 1.8–2.4 mm long. *Anthers* 0.6–0.7 mm wide from front view; connective gland 0.5–0.6 mm long; thecae 0.3–0.4 mm long. *Ovary* c. 2/3 inferior; ovules (13–)15–18. *Style* 3.5–3.7 mm long; stigma 0.3–0.4 mm diam. *Fruits* c. 2/3 inferior, 4–5 mm long, 5.5–6 mm diam.; placentas elliptic, 2.3–2.4 \times 1.3–1.7 mm. *Seeds* faceted, 1.4–1.7 mm long, 0.6–1 mm wide, 0.6–1 mm thick, dark brown, colliculate; inner cavity 0.3–0.4 mm long. (Figure 1L)

Diagnostic features. Distinguished from other species of sect. *Tilophloia* by its usually greater height of 0.7–1.2 m, its broad stigma, and its dark brown seeds with a cavity only 0.3–0.4 mm long (much shorter than the seed).

Selected specimens examined. WESTERNAUSTRALIA: [localities withheld for conservation reasons] 30 Mar. 2004, P. Armstrong PA 19 (PERTH); 20 Oct. 1964, J.S. Beard 3728 (PERTH); 3 Aug. 2005, G.F. Craig 6702 A (PERTH); 10 Nov. 2005, G.F. Craig 7029 (PERTH); 11 Oct. 1965, F. Humphreys s.n. (PERTH); 15 Sep. 2011, P. Knapton 19 (PERTH); 4 Sep. 1970, K.R. Newbey 3284 (PERTH); 31 July 1980, K.R. Newbey 6834 (PERTH); 24 Sep 1971, C.I. Stacey 29 (PERTH); 16 Oct. 1997, Peter G. Wilson 1396 & N. Lam (NSW n.v., PERTH).

Distribution and habitat. Recorded from Hatter Hill south to the western end of Frank Hann National Park (Figure 10), often in gravelly soils but also rocky soils with quartz pebbles. The vegetation is often dominated by *Melaleuca*, *Allocasuarina* or *Eucalyptus*.

Phenology. Flowers recorded from late June to November. Mature fruits recorded in November and March.

Etymology. From the Greek *thamnos* (bush, shrub) and the adjectival suffix *-oides* (indicating resemblance), referring to the fairly erect, shrubby habit of this species (most members of the genus are low-growing).

Conservation status. Listed as Priority Two under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Baeckea* sp. Hatter Hill (K.R. Newbey 3284). Known only from a small area.

Affinities. See the notes below under *Baeckea* sp. Yorkrakine (C.A. Gardner s.n. 09/1933), which appears to be closely related to *B. thamnoides*. *Balaustion thamnoides* is atypical of section *Tilophloia* in its somewhat taller habit, broad stigma, and its darker-coloured and more strongly faceted seeds with a small cavity in relation to the seed size. Its seeds, up to 1.7 mm long, are among the largest in the section yet have the smallest cavity (0.3–0.4 mm long). Flower-subtending leaves tend to be distinctive in this species, having broader scarious margins than other leaves, or sometimes appearing to be prominently winged on each side (e.g. *C.I. Stacey* 29) in which case they are shorter and much broader than the vegetative leaves. Despite these differences, *B. thamnoides* still seems to fit within sect. *Tilophloia*.

Balaustion karroun resembles *B. thamnoides* in having large bracteoles, leaves with a distally rounded keel and a 2/3 inferior fruit, but differs in its lower habit, narrower stigma and larger seed cavity.

Notes. Sepals tend to be widely spreading in fruit, giving the fruit an apparent diameter of up to 9 mm.

18. *Balaustion unguiculatum* Rye, *sp. nov.*

Type: north-north-west of Bullfinch, Western Australia [precise locality withheld for conservation reasons], 2 October 1981, K.R. Newbey 9195 (*holo:* PERTH 06748473; *iso:* CANB, K, MEL).

Baeckea sp. Yacke Yackine Dam (K.R. Newbey 9195), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Shrub 0.2–0.5 m high, recorded as 0.35–0.4 m wide; flowering branchlets with 1 pair of flowers. *Leaves* antrorse or widely antrorse. *Petioles* 0.5–0.6 mm long. *Leaf blades* obovate to almost circular-cordate, 2–3.5 mm long, 1.2–1.6 mm wide, thin, flat on average, the margins often either recurved or incurved, obtuse to truncate, entire or minutely serrulate on margins; abaxial surface keeled towards apex, the keel suddenly produced into a prominent subterminal ridge and not obvious as a keel elsewhere, with the larger oil glands usually in 2–4 main rows on each side of midvein; adaxial surface often somewhat pinched in towards apex, with oil glands similar to those on abaxial surface. *Peduncles* 2–3 mm long, curved, laterally somewhat ridged, somewhat glandular-rugose. *Bracteoles* shed from very young buds, *c.* 2.5 mm long. *Pedicels* 1–3 mm long. *Flowers* *c.* 13 mm diam. *Hypanthium* 2–2.5 mm long, *c.* 4 mm wide, green, somewhat rugose and gland-dotted; free part *c.* 0.7 mm long. *Sepals* depressed ovate, 1.3–1.6 mm long, 2–3 mm wide, somewhat scarious, deep pink with an irregular white border up to 0.3 mm wide in places, \pm entire. *Petals* 4.5–5.5 mm long, white, tinged pink. *Stamens* 20–22. *Antipetalous filaments* 2–2.4 mm long. *Anthers* *c.* 0.5 mm wide from front view; connective gland 0.4–0.5 mm long; thecae 0.35–0.4 mm long. *Ovary* *c.* 1/2 inferior; ovules 12–17 per loculus. *Style* *c.* 3.5 mm long; stigma 0.2–0.3 mm diam. *Fruits* over 1/2 and up to 2/3 superior, *c.* 3.5–4 mm long, *c.* 4 mm diam.; placentas elliptic or ovate, *c.* 2.6 \times 1.3 mm. *Seeds* reniform but somewhat faceted, 1.4–1.5 mm long, 0.8–0.9 mm wide, 0.6–0.9 mm deep, golden brown, colliculate; inner cavity 0.6–0.9 mm long. (Figure 1A)

Diagnostic features. Distinguished from other species of sect. *Tilophloia* by its scarcely thickened, obovate to almost circular-cordate leaves, with an abrupt, subterminal ridge on the abaxial surface.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 2 June 2010, *S. Reiffer* SRE 181 (PERTH); 9 Sep. 2010, *S. Reiffer* SRE 300 (PERTH).

Distribution and habitat. Associated with granite outcrops in a small area north of Bullfinch (Figure 3).

Phenology. Flowers recorded in September and October.

Etymology. From the Latin *unguiculatus* (clawed), referring to the leaves having an abrupt subterminal projection, which resembles a small claw, on their abaxial surface.

Conservation status. Listed as Priority One under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Baeckea* sp. Yacke Yackine Dam (K.R. Newbey 9195).

Affinities. A very distinctive species, with leaves less thickened than in all other members of sect. *Tilophloia* and unusual in having peduncle and pedicel lengths similar. See the notes under *B. tangerinum*, which shows the closest approach to it in leaf shape and might possibly be a hybrid between it and *B. pulcherrimum* (see also Table 3).

Notes. Bracteoles were only seen on one very young bud in this poorly known species.

Phrase names transferred to *Balaustion*

Three poorly known taxa that have been known by phrase names under *Baeckea* are transferred to *Balaustion* but retained under informal names for now. They need further study to establish their taxonomic status.

Balaustion sp. **Billyacatting Hill** (A.S. George 14349)

Baeckea sp. Billyacatting Hill (A.S. George 14349), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Conservation status. Recently listed as Priority Two under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Baeckea* sp. Billyacatting Hill. Currently known from a single nature reserve.

Notes. Previously known as *Baeckea* sp. Billyacatting Hill (A.S. George 14349), this member of the *Balaustion exsertum* group occurs in the northern part of the group's distribution (Figure 10) and differs from *B. exsertum* and *B. quinquelobum* in its habitat associated with granite. *Balaustion* sp. Billyacatting Hill possibly shows the greatest tendency for a low-growing, more or less prostrate habit in the group. It resembles *B. quinquelobum* in having a short style but lacks the degree of lobing of the hypanthium found in that species.

Balaustion sp. **North Ironcap** (R.J. Cranfield 10580)

Baeckea sp. North Ironcap (R.J. Cranfield 10580), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Baeckea sp. Lake Cronin (K.R. Newbey 9191), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Conservation status. To be listed as Priority One under Conservation Codes for Western Australian Flora (Tanya Llorens pers. comm.). *Baeckea* sp. Lake Cronin and *B.* sp. North Ironcap, now considered to be synonymous, were both previously listed as Priority One (Western Australian Herbarium 1998–).

Notes. *Balaustion* sp. North Ironcap is not included in the key to species and subspecies, although it is still mapped (Figure 8). It is very similar to *B. grandibracteatum* but differs in having subterminal knobs common on its leaves. Its bracteoles have mostly fallen from the specimens but the very few observed are 2.2–2.5 mm long, suggesting that *B.* sp. North Ironcap is close to *B. grandibracteatum* subsp. *meridionale*. However, if *B.* sp. North Ironcap were keyed out it would need to be included with the species that have subterminal points or knobs on their leaves rather than with *B. grandibracteatum*.

***Balaustion* sp. Yorkrakine** (C.A. Gardner s.n. 09/1933)

Baeckea sp. Yorkrakine (C.A. Gardner s.n. 09/1933), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 2 February 2022].

Conservation status. Listed as Priority One under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Baeckea* sp. Yorkrakine (C.A. Gardner s.n. 09/1933).

Notes. *Balaustion* sp. Yorkrakine is possibly conspecific with *B. thamnoides* but occurs further west (Figure 10) and differs in its smaller, usually thicker leaves, with less obviously scarious and denticulate margins. It may also tend to have smaller flowers with fewer ovules and a more rugose-pitted hypanthium, but these characters are difficult to judge from the few flowers examined. As this taxon is only known from one specimen that lacks habit details and fruits, it is too poorly known to determine whether it shares the unusual habit and seed characters found in *B. thamnoides*.

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References

- Bentham, G. (1867). *Flora Australiensis*. Vol. 3. (Reeve & Co.: London.)
- Blackall, W.E. & Grieve, B.J. (1954). *How to Know Western Australian Wildflowers*. Part 1. (West Australian Newspapers Ltd: Perth.)
- Diels, L. & Pritzel, E. (1904). Myrtaceae. Fragmenta Phytographiae Australiae Occidentalis. *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie* 35: 398–444.
- Gardner, C.A. (1927). Contributiones florae Australiae Occidentalis VI. *Journal and Proceedings of the Royal Society of Western Australia* 13: 61–68.

- Griffin, E.A. (1994). *Floristic survey of Northern sandplains between Perth and Geraldton*. Department of Agriculture and Food, Western Australia, Perth. Report 144.
- Harvey, W.H. (1855). Characters of some new genera of plants recently discovered by Mr James Drummond in Western Australia. *Hooker's Kew Journal of Botany and Kew Garden Miscellany* 7: 51–58.
- Hooker, W.H. (1851). *Balaustion pulcherrimum* Hook. *Hooker's Icones Plantarum* 9: tab. 852.
- Lam, N., Wilson, P.G., Heslewood, M.M. & Quinn, C.J. (2002). A phylogenetic analysis of the *Chamelaucium* alliance (Myrtaceae). *Australian Systematic Botany* 15: 535–543.
- Moore, S. le M. (1920). A contribution to the flora of Australia. *Journal of the Linnaean Society, Botany* 45: 159–220.
- Niedenau, F. (1893). Myrtaceae. In: Engler, A. & Prantl, K. (eds) *Die Natürlichen Pflanzenfamilien*. Vol. 3(7), 57–105. (Engelmann: Leipzig.)
- Paczkowska, G. & Chapman, A.R. (2000). *The Western Australian Flora: a Descriptive Catalogue*. (Wildflower Society of Western Australia; Western Australian Herbarium: Perth, Western Australia.)
- Rye, B.L. (1979). Chromosome number variation in the Myrtaceae and its taxonomic implications. *Australian Journal of Botany* 27: 547–573.
- Rye, B.L. (2009a). A reduced circumscription of *Balaustion* and description of the new genus *Cheyniana* (Myrtaceae: Chamelaucieae). *Nuytsia* 19: 129–148.
- Rye, B.L. (2009b). An interim key to the Western Australian tribes and genera of Myrtaceae. *Nuytsia* 19: 313–323.
- Rye, B.L. (2017). An expanded circumscription and new infrageneric classification of *Rinzia* (Myrtaceae: Chamelaucieae). *Nuytsia* 28: 39–93.
- Rye, B.L., Wilson, P.G. & Keighery, G.J. (2013). A revision of the species of *Hypocalymma* (Myrtaceae tribe Chamelaucieae) with smooth or colliculate seeds. *Nuytsia* 23: 283–312.
- Rye, B.L., Wilson, P.G., Heslewood, M.M., Perkins, A.J. & Thiele, K.R. (2020). A new subtribal classification of Myrtaceae tribe Chamelaucieae. *Australian Systematic Botany* 33: 191–206.
- Sharr, F.A. (2021). *Western Australian Plant Names and their Meanings*. Fourth edition by A.S. George. (Four Gables Press: Kardinya, Western Australia.)
- Turczaninow, N. (1852). Myrtaceae xerocarpicae, in Nova Hollandia. *Bulletin de la Classe Physico-Mathématique des Sciences di Saint-Petersburg* 10: 322–346.
- Western Australian Herbarium (1998–). *Florabase—the Western Australian flora*. Department of Biodiversity, Conservation and Attractions. <https://florabase.dpaw.wa.gov.au/> [accessed 7 June 2022].
- Wilson, P.G., Heslewood, M., Lam, N. & Quinn, C. (2004). Progress towards a phylogeny of the *Chamelaucium* alliance (Myrtaceae). *Australian Biologist* 17: 28–33.

***Conostephium wonganense*, *Dielsiodoxa altimontana*
and *Styphelia blackallii* – three rare, new epacrids (Ericaceae:
Epacridoideae) from Western Australia**

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SHORT COMMUNICATION

Conostephium wonganense* Hislop, *sp. nov.

Typus: east of Konnongorring, Western Australia [precise locality withheld for conservation reasons], 13 September 2005, *M. Hislop* 3514 (*holo*: PERTH 07420463; *iso*: CANB, K, MEL, NSW).

Erect *shrubs* to *c.* 1.2 m high and 1.2 m wide, multi-stemmed at ground level with a fire-resistant rootstock. Young *branchlets* with a moderately dense to dense indumentum of patent to shallowly antrorse, straight or distinctly curved hairs, of mixed lengths, the longest to *c.* 1 mm long. *Leaves* antrorse, usually steeply so; apex long-mucronate, rather coarsely pungent, the mucro 0.6–0.9 mm long, straight to slightly inflexed; base cuneate or less often attenuate; petiole moderately well-defined, 0.4–1.0 mm long, usually sparsely hairy throughout; lamina usually linear, occasionally very narrowly elliptic or very narrowly triangular, 9–21 mm long, 1.0–2.3 mm wide, adaxially convex, margins strongly recurved to revolute, longitudinal axis \pm straight; surfaces markedly discolorous; adaxial surface mostly glabrous or with a few hairs towards the base and about the apex, venation usually obvious, manifesting as sunken lines; abaxial surface much paler with 7–9 raised primary veins, \pm openly grooved between, the midrib not differentiated, sparsely hairy throughout to \pm glabrescent; margins ciliate with hairs to *c.* 0.5 mm long, although these often obscured by the revolute margins. *Inflorescence* axillary, pendulous or sub-pendulous; axis 2.2–3.0 mm long, hairy, in large part obscured by imbricate bracts. *Axis bracts* 5–10, grading upwards from depressed-ovate to broadly ovate, the two uppermost, 2.0–3.2 mm long, 1.5–3.0 mm wide. *Floral bracts* 3–4, broadly ovate, 3.0–5.4 mm long, 2.3–3.7 mm wide, obtuse, mucronate, often coloured dark purple towards the apex. *Bracteoles* ovate, 4.8–7.0 mm long, 3.0–3.8 mm wide, obtuse, mucronate; abaxial surface hairy with a dense indumentum of spreading hairs, mostly straw-coloured, but often becoming dark purple towards the apex, multi-veined and striate; adaxial surface glabrous; margins ciliate. *Sepals* ovate to narrowly ovate, 6.1–8.4 mm long, 2.7–3.5 mm wide, the apices grading from obtuse and mucronate in the outer sepals to subacute or acute in the inner; abaxial surface hairy with a dense indumentum of spreading hairs, mostly straw-coloured, often becoming dark purple towards the apex, multi-veined and striate; adaxial surface glabrous; margins ciliate with hairs to 0.2 mm long. *Corolla* shed soon after anthesis. *Corolla tube* \pm actinomorphic, essentially fusiform, the widest part (the bulge) at *c.* the middle, 9.5–12 mm long, 2.8–3.5 mm wide, exposed portion dark purple; external surface glabrous or with a few appressed hairs,

rugose in the coloured portion; internal surface densely hairy (with a mixture of antrorse and retrorse hairs) from the base of the lobes to the top of the ovary, the densest and longest hairs (1.0–1.5 mm long) arising from the tube below the bulge and coalescing into several \pm well-defined longitudinal bands of hair, these overlapping with the base of the anthers. *Corolla lobes* white, erect basally and then spreading in the upper half, 0.4–1.0 mm long, 0.4–0.5 mm wide at base, internal surface glabrous apart from a few antrorse hairs towards the base, hairs not visible at the connivent bases of adjoining lobes. *Filaments* 1.7–2.0 mm long, 0.35–0.50 mm wide, flattened, hairy on the adaxial surface below the connective, the connective abruptly and prominently thickened, dark brown, attached *c.* 1/2 above anther base, adnate to tube at *c.* the middle. *Anthers* 3.0–4.1 mm long, the lobes 1/3–1/2 the length of the anthers. *Nectary* annular, very shallowly lobed, 0.1–0.2 mm long. *Ovary* ovoid to \pm globose, 1.2–1.6 mm long, 1.1–1.6 mm wide, glabrous, 5-locular. *Style* 10.3–12.8 mm long, glabrous. *Fruit* broadly ovoid, 5.5–6 mm long and 5.5–6 mm wide (refer comment under notes below), apex obtuse, surface prominently rugose in dried specimens; endocarp \pm smooth. (Figure 1A)

Diagnostic characters. *Conostephium wonganense* can be distinguished from all other members of the genus by the following character combination: inflorescence axis 2.2–3.0 mm long; upper corolla tube dark purple; internal corolla tube densely hairy (hairs longest about the base of the anthers), forming more or less well-defined longitudinal bands extending from the base of the bulge to a point adjacent to the top of the ovary; corolla lobes 0.4–1.0 mm long; filaments adnate to the tube at about the middle; anther connective abruptly and prominently thickened, dark brown.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 4 Sep. 1982, *J.H. Ross* 2762 (MEL, NSW, PERTH); Aug. 1970, *Mrs B.H. Smith s.n.* (PERTH); Sep. 1970, *B.H. Smith s.n.* (PERTH); 1 Sep. 1978, *B. & M. Smith s.n.* (PERTH).

Distribution and habitat. Known only from the Wongan Hills area of the Avon Wheatbelt bioregion. At the type locality the species is growing in yellow sandy loam in open mallee over medium density shrubs. Associated species include *Eucalyptus pyriformis*, *Leptospermum erubescens*, *Verticordia eriocephala* and *Callitris pyramidalis*. At least six other drupaceous epacrids also occur at this site, including *Conostephium preissii*.

No site information was recorded for the various *Smith* collections, but *J.H. Ross* 2762 is said to have been collected from ‘sandy loam in *Eucalyptus salmonophloia* woodland’. This statement appears rather problematic in that *E. salmonophloia* usually occurs in soils that are heavier than ‘sandy loam’ and within the author’s experience no epacrids are associated with typical Salmon Gum woodlands.

Phenology. All collections have been made in August or September and all, apart from one, are in late flower, suggesting that peak flowering is likely to be in the period June to August. The exception is *B.H. Smith s.n.*, which consists of mature fruit only.

Etymology. The epithet is derived from the place name Wongan Hills and *-ensis* (native of). The fact that many species now bear this epithet is indicative of the importance of the area as a centre of botanical diversity in the Western Australian wheatbelt.

Conservation status. To be listed as Priority One under the Conservation Codes for Western Australian Flora (Tanya Llorens pers. comm.). Known from very few collections, south and east of Wongan Hills. Efforts by the author to relocate the species in the latter area, where all the older collections are from, have been unsuccessful. The locality statements associated with these specimens are rather vague but

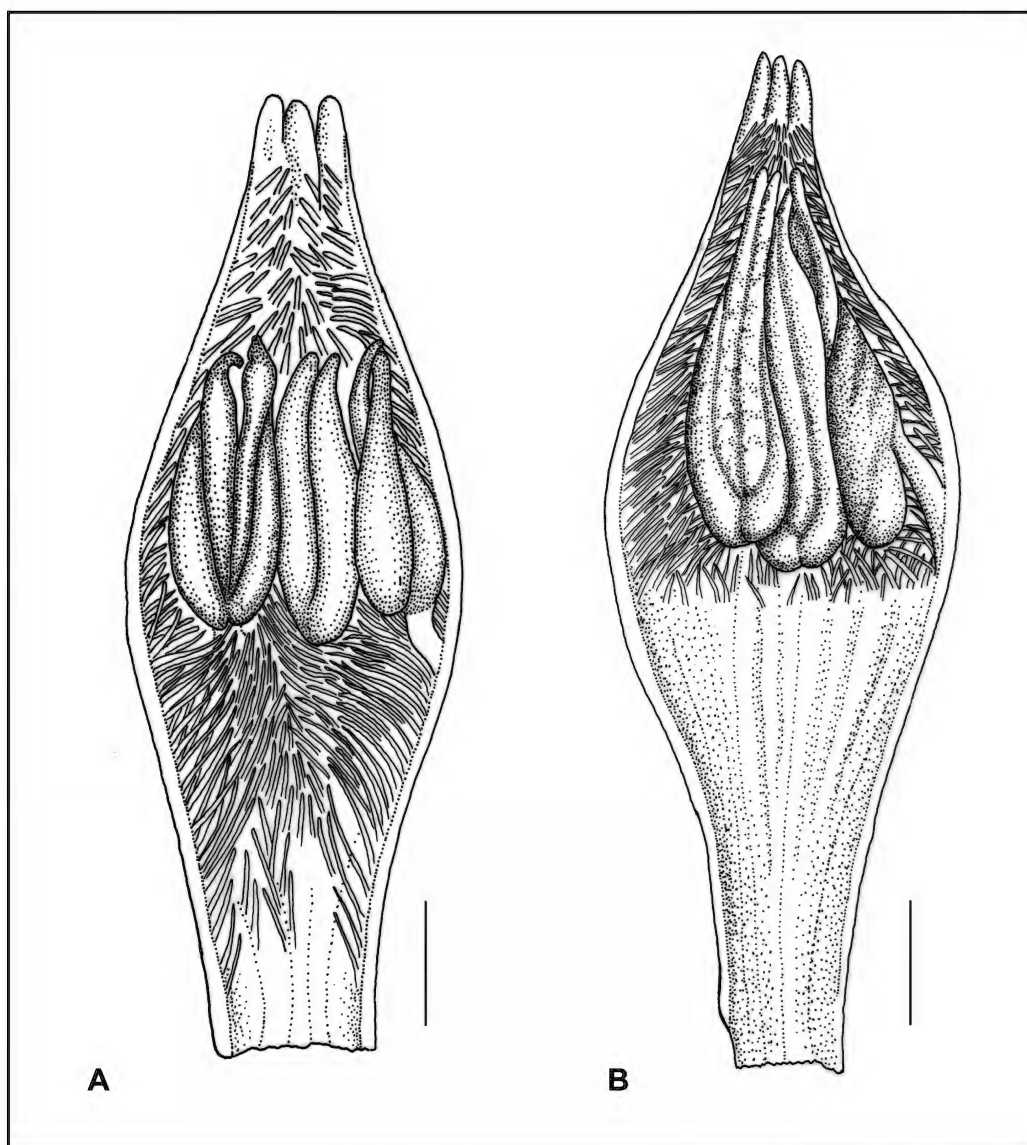


Figure 1. Longitudinal corolla sections showing internal surfaces. A – *Conostephium wonganense*; B – *C. hortiorum*. Scale bars = 2 mm. Vouchers M. Hislop 3514 (A), F. Hort, J. Hort & L.W. Sage 597 (B). Drawings by Skye Coffey.

it is clear that the collection sites are close to one another, and it is even conceivable that all were made in the same bush block. The type locality is a small area of remnant bushland south of Wongan Hills.

This plant occurs in a part of the wheatbelt that is relatively well-known botanically and the fact that so few collections have been made gives strong indication that it is likely to be rare. Short-range endemism is well-known among Western Australian epacrids and it may well be the case that the species was already very restricted geographically when this part of the state was cleared for agriculture.

Conostephium wonganense is much in need of further survey work in an effort to establish whether it persists anywhere on the conservation estate in the Wongan Hills area.

Affinities. The possibility that an undescribed taxon, similar to *C. hortiorum* Hislop, might occur in the Wongan Hills area was discussed briefly under the notes heading in the description of that species (Hislop 2013: 322). At the time of writing the author was only aware of one collection (*M. Hislop* 3514) from south of Wongan Hills. Not long after publication however, other older collections from east of the town became available. These had the same morphological attributes as *M. Hislop* 3514 and strengthened the case that a new species did indeed need to be recognised.

Conostephium wonganense is one of a group of species characterised by fragrant flowers, dark purple corolla tubes, strongly thickened, brown anther connectives and the presence of very short nectaries (the remaining species are without nectaries), the others being *C. hortiorum*, *C. pendulum* Benth., *C. prolatum* Hislop and *C. roei* Benth. Among this group it is closest morphologically and geographically to *C. hortiorum* and *C. pendulum*.

In gross morphology *C. wonganense* appears closest to *C. hortiorum*. The most significant difference between the two relates to the internal corolla tube indumentum. In *C. wonganense* the hairs extend from the base of the lobes to a point adjacent to the top of the ovary and coalesce into more or less, well-defined, longitudinal bands below the base of the bulge. The hairs are longest (1–1.5 mm long) about the base of the anthers and overlap with those, becoming distinctly shorter towards the ovary (Figure 1A). The hairs are more restricted in *C. hortiorum*, usually extending only as far as the base of the bulge or occasionally with sparse, short hairs below the bulge to a point about halfway to the ovary (Figure 1B).

There are also differences between the two species in the size of some floral parts (measurements for *C. hortiorum* given in parentheses): corolla lobes 0.4–1.0 mm long in *C. wonganense* (cf. 1.2–2.4 mm); sepals 6.1–8.4 mm long (cf. 8.5–10.8 mm); anthers 3.0–4.1 mm long (cf. 3.8–5.6 mm); inflorescence axis 2.2–3.0 mm long (cf. 2.8–5.2 mm). The two can also be distinguished by a difference in the indumentum of the abaxial leaf surface. In *C. wonganense* this indumentum mostly consists of rather sparse, long hairs (occasionally ± glabrescent), whereas in *C. hortiorum* it is noticeably denser with a predominance of short hairs, especially within the grooves.

Conostephium wonganense can be readily distinguished from *C. pendulum* by its obviously shorter inflorescence axis, 2.2–3.0 mm long, compared to 5.4–10.2 mm in *C. pendulum*. There is also an important difference between the two in regard to the internal corolla tube indumentum. In contrast to the hair distribution of *C. wonganense*, described above, *C. pendulum* has five more or less discrete hair tufts situated towards the base of the tube adjacent to ovary. The surfaces between the base of the bulge and the hair tufts are shortly and sparsely hairy or more or less glabrous.

Notes. The description of the fruit given above is based on a single collection and must therefore be regarded as provisional.

Identification. The new species can be accommodated in Hislop's (2013) key by the addition of an extra couplet:

13. Branchlet indumentum very short, uniform in length, to c. 0.1 mm long; leaves obovate, narrowly obtriangular or occasionally linear; sepals 4.8–7.5 mm long; corolla lobes 0.4–0.6 mm long (Fitzgerald River National Park) ***C. prolatum***

- 13:** Branchlet indumentum of mixed lengths, the longer hairs, 0.5–1.2 mm long; leaves linear, very narrowly triangular or very narrowly elliptic; sepals 6.1–10.8 mm long; corolla lobes 0.4–2.4 mm long
- 14.** Internal corolla tube densely hairy from the base of the lobes to a point adjacent to the top of the ovary, the hairs coalescing into \pm well-defined longitudinal bands below the base of the bulge; inflorescence axis 2.2–3.0 mm long; sepals 6.1–8.4 mm long; corolla lobes 0.4–1.0 mm long; anthers 3.0–4.1 mm long (Wongan Hills area) **C. wonganense**
- 14:** Internal corolla tube densely hairy from the base of the lobes to the base of the bulge, usually glabrous below the bulge or occasionally with sparse hairs extending to a point *c.* halfway between the bulge and the top of the ovary; inflorescence axis 2.8–5.2 mm long; sepals 8.5–10.8 mm long; corolla lobes 1.2–2.4 mm long; anthers 3.8–5.6 mm long (eastern Darling Range) **C. hortiorum**

Dielsiodoxa altimontana* Hislop, *sp. nov.

Typus: Stirling Range National Park, Western Australia [precise locality withheld for conservation reasons], 19 February 2021, *D.A. Rathbone* DAR 1061 (*holo:* PERTH 09332219).

Low, spreading *shrubs*, to about 20 cm high and 30 cm wide, from a fire-sensitive rootstock. Young *branchlets* with a sparse to moderately dense indumentum of variably orientated, straight or curved hairs, to *c.* 0.3 mm long; leaf abscission scars 0.1–0.2 mm wide. *Leaves* spirally arranged, mostly steeply antrorse, densely imbricate, readily abscising, often only a cluster of terminal leaves retained on dried specimens; apex attenuate, very fine, with one or sometimes two terminal hairs; base attenuate; petiole absent; lamina thin-textured, very narrowly ovate, very narrowly elliptic to \pm linear, 2.5–5.5 mm long, 0.2–0.8 mm wide (l:w ratio 6–16: 1), usually slightly concave adaxially or \pm flat, longitudinal axis gently to strongly incurved; surfaces pale green, \pm concolorous, slightly shiny; adaxial surface glabrous or with a few long hairs present, the midvein usually obscurely evident; abaxial surface glabrous or with a few long hairs present, the midvein and sometimes a vein on either side, usually evident, shallowly grooved between the veins; margins ciliate with hairs to 0.5 mm long. *Inflorescence* axillary, erect to \pm spreading, 1–3-flowered, axis 0.8–1.6 mm long, glabrous or with very few hairs, either terminating at a flower or produced into a very short, blunt projection; flowers erect, pedicellate above the bracteoles, with a short, thick pedicel, *c.* 0.2 mm long. *Fertile bracts* narrowly ovate to ovate, 0.25–0.35 mm long, 0.20–0.25 mm wide, with 2 or 3 sterile bracts on the lower part of the axis. *Bracteoles* ovate, broadly ovate to \pm orbicular, 0.2–0.4 mm long, 0.2–0.3 mm wide, obtuse; abaxial surface glabrous; margins ciliate. *Sepals* ovate to broadly ovate, 0.40–0.55 mm long, 0.3–0.5 mm wide, obtuse to subacute; abaxial surface green, becoming white towards the margins, glabrous, the mid-vein usually prominent; adaxial surface glabrous; margins ciliate with hairs to *c.* 0.05 mm long. *Corolla tube* white, shallowly funnelform, clasping the base of the ovary, *c.* as long as the sepals, 0.7–0.8 mm long, 0.8–0.9 mm wide, glabrous throughout. *Corolla lobes* white, longer than the tube, 1.0–1.1 mm long, 0.5–0.6 mm wide, spreading widely from the base, glabrous throughout, with 3 veins prominent. *Filaments* terete, 0.5–0.6 mm long, attached to anther *c.* 1/2 above anther base, adnate to tube just below sinuses. *Anthers* well-exserted from the tube, 0.20–0.25 mm long. *Nectary* partite, the scales minute, narrowly ovate to narrowly elliptic, 0.15–0.25 mm long, *c.* 0.1 mm wide, glabrous. *Ovary* obovoid to ellipsoid, 0.6–0.8 mm long, 0.4–0.5 mm wide, 2-locular, with prominent, elongate papillae (to *c.* 0.1 mm long) in the upper half, glabrous below. *Style* 0.3 mm long, glabrous; stigma prominently 2-lobed. Mature *fruit* not seen. (Figures 2A, 3)

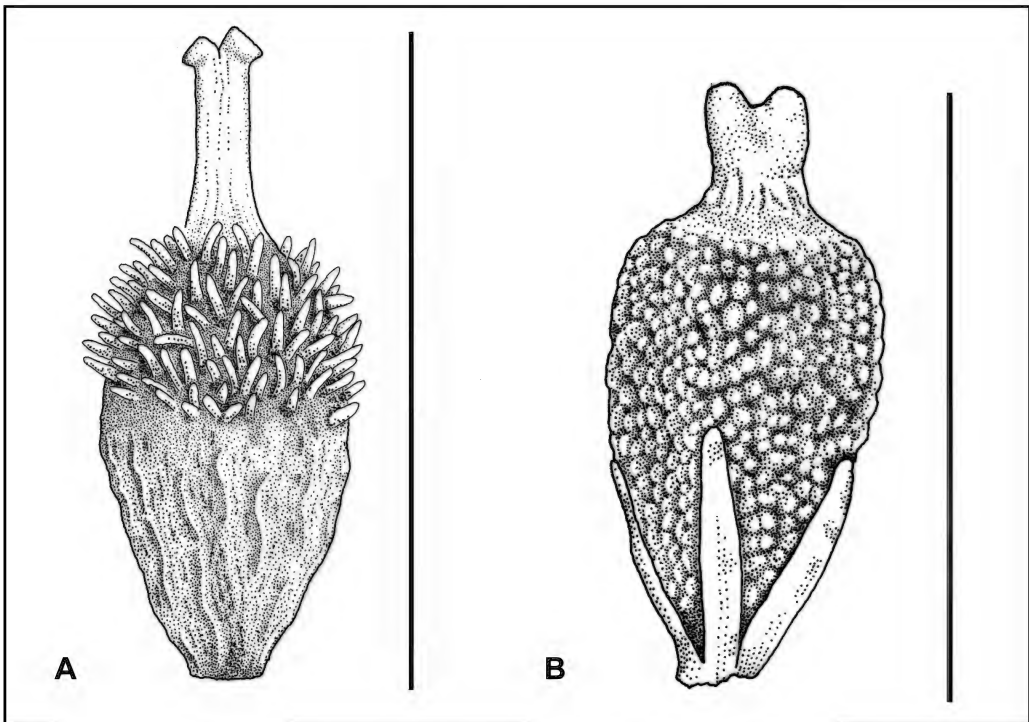


Figure 2. Comparison of gynoecium features. A – *Dielsiodoxa altimontana* with nectary scales removed; B – *D. lycopodioides* with nectary scales. Scale bars: A = 1 mm; B = 0.8 mm. Vouchers *D. Rathbone* DAR 1061 (A), *R.J. Cranfield* 14877 (B). Drawings by Skye Coffey.

Diagnostic characters. Readily distinguished within the genus by the following character combination: leaves very narrowly ovate, very narrowly elliptic to \pm linear, 2.5–5.5 mm long, 0.2–0.8 mm wide, ciliate with hairs to 0.5 mm long and terminating in 1 or sometimes 2 hairs; flowers pedicellate above the bracteoles with a short thick pedicel, *c.* 0.2 mm long; ovary with prominent, elongate papillae, to *c.* 0.1 mm long; style 0.3 mm long.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 3 Nov. 2021, *M. Dilly & S. Barrett* SB 2324 (PERTH); 4 Nov. 2021, *M. Dilly & S. Barrett* SB 2326 (PERTH); 12 Nov. 1961, *A.S. George* 3127 (PERTH); 13 Nov. 1944, *R.J. Moir s.n.* (PERTH).

Distribution and habitat. Occurs in a small part of the eastern Stirling Range in the far west of the Esperance Plains bioregion where it grows on upper mountain slopes, usually in damp, sheltered sites, in loam over quartzite (Figure 3). Some associated species include, *Goodenia brendannarum*, *Actinotus rhomboideus*, *Platysace* sp. Stirling (*J.M. Fox* 88/262) and *Drosera monticola*.

Phenology. All specimens were collected in late spring or summer and are at various stages of flowering, with some immature fruit present in *A.S. George* 3127.

Etymology. From the Latin *altus* (high) and *montanus* (pertaining to a mountain), a reference to the fact that the species occurs only in the highest parts of the Stirling Range.



Figure 3. *Dielsiodoxa altimontana*. Young plants *in situ*. Voucher M. Dilly & S. Barrett SB 2324. Photograph by Megan Dilly.

Conservation status. To be listed as Priority Two under the Conservation Codes for Western Australian Flora (Tanya Llorens pers. comm.). This species is known with certainty only from the upper slopes of two neighbouring mountain peaks in the eastern Stirling Range, where there are at least many dozen plants, although following recent fire, most of those are young (Sarah Barrett pers. comm.). Threatening processes include the confirmed presence in these general areas of the root-rot pathogen, *Phytophthora cinnamomi* and possibly grazing pressure from quokkas, as the plant has been observed to be preferentially grazed by the small marsupial (Megan Dilly & Sarah Barrett pers. comm.).

Affinities. Under the notes heading in their treatment of *Dielsiodoxa lycopodioides* Albr., Albrecht and Hislop (2011) discussed two geographically disjunct and morphologically anomalous specimens (R.J. Moir s.n. and A.S. George 3127), which they tentatively referred to that species. At the time it was felt that because the specimens were old (the most recent of the two then 50 years old) and fragmentary, it was desirable to see better material before a final decision was taken on their taxonomic status. The recent rediscovery of the same morphotype has enabled a proper comparison between it and *D. lycopodioides* and it is now quite clear that the two cannot be considered conspecific.

Dielsiodoxa lycopodioides is a locally common species with a somewhat disjunct distribution in the wettest parts of the south-west of Western Australia, around Walpole, Denmark and Mount Manypeaks. It

shares with *D. altimontana* relatively long and narrow leaves and narrow leaf abscission scars. However, the two species differ in respect to several significant floral characters. Maybe the most interesting of these is the presence in *D. altimontana* of a short, thick pedicel between the bracteoles and the base of the sepals. This is a unique feature within the genus, with all other species having sessile flowers. Another clear difference is in the texture of the ovary. Whereas *D. altimontana* has elongate papillae (to c. 0.1 mm long) arising from the ovarian surface in the upper half (Figure 2A), in *D. lycopodioides* the surface is minutely pustulate throughout (Figure 2B). A further difference in the gynoecium between the two is the noticeably longer style of *D. altimontana* (0.3 mm long), compared to 0.1–0.2 mm in *D. lycopodioides*. There is also a rather unexpected leaf character that sets *D. altimontana* apart from *D. lycopodioides* and all other congeners. Where the leaf apices of the other species either terminate in a short thickened mucro or else entirely lack a mucro, in *D. altimontana* the leaves terminate in one or sometimes two hairs that are indistinguishable in texture from the marginal cilia.

Two other taxa of *Dielsiodoxa* occur in the Stirling Range, *D. tamariscina* (F.Muell.) Albr. and *D. leucantha* subsp. *obtusata* Hislop & Albr. Neither of those taxa have pedicellate flowers, ovaries with elongate papillae or leaves that terminate in hairs. In addition, *D. tamariscina* can be readily distinguished by the presence of hairs on the corolla tube and lower surfaces of the corolla lobes. *Dielsiodoxa tamariscina* grows in close proximity to *D. altimontana* at one of the known localities of the new species. *Dielsiodoxa leucantha* subsp. *obtusata* is further distinguished from *D. altimontana* by its shorter leaves (to 3 mm long, cf. 2.5–5.5 mm in *D. altimontana*), that are essentially ovate or elliptic (cf. very narrowly ovate, very narrowly elliptic to \pm linear) and have minutely ciliolate margins with hairs rarely as long as 0.1 mm (cf. cilia to 0.5 mm long).

Notes. In early 2021 the author mentioned the subject of the aberrant *Dielsiodoxa* specimens to Albany-based Flora Conservation Officer, Sarah Barrett, during correspondence regarding the potential appearance of unfamiliar plants in recently burnt country in the Stirling Range. Given the age of the *Moir* and *George* specimens and the fact that *Phytophthora cinnamomi* had spread rapidly in the national park in the intervening decades, I was not confident that the plant still survived. Sarah forwarded the information to Damien Rathbone, another local botanist who knows the range well and shortly afterwards he retrieved an image taken during survey work that conclusively showed that it was indeed still extant.

Identification. The new species can be accommodated in Albrecht and Hislop's (2011) key by the modification of couplet 3 and the addition of a new couplet, 3a:

3. Ovary and fruit pustulate or with elongate papillae; mature leaves \pm linear, narrowly ovate, narrowly elliptic, ovate or narrowly rhombic, 0.8–5.5 mm long, 0.2–1.1 mm wide, with l:w ratio of 2–13: 1; 1–7 veins weakly visible on the abaxial leaf surface; raised abscission scars 0.10–0.35 mm wide
 - 3a. Flowers pedicellate above the bracteoles, with short, thick pedicels; ovary and fruit with prominent, elongate papillae; style 0.3 mm long (eastern Stirling Range) ***D. altimontana***
 - 3b. Flowers sessile; ovary and fruit pustulate; style 0.1–0.2 mm long (Walpole area, Denmark area and Mt Many Peaks) ***D. lycopodioides***
3. Ovary and fruit smooth or with minute, dense, slightly raised, elongate surface cells; mature leaves ovate, elliptic, depressed-ovate or rhombic-elliptic, 1.3–3.0 mm long, 0.9–2.5 mm wide, with l:w ratio of 0.7–2.1: 1; 7–13 veins visible on the abaxial surface; raised abscission scars (0.3)0.4–0.7 mm wide..... **4**

Styphelia blackallii* Hislop, *sp. nov.

Typus: Tarin Rock, Western Australia [precise locality withheld for conservation reasons], 12 December 2018, *M. Hislop* 4786 (*holo*: PERTH 09154493; *iso*: CANB, CNS, MEL, NSW).

Styphelia sp. Tarin Rock (W.E. Blackall 1315), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 21 April 2022].

Dense, tangled *shrubs* to c. 100 cm high and 120 cm wide, multi-stemmed at the base but apparently with a fire-sensitive rootstock. Young *branchlets* with a moderately dense to dense indumentum of \pm patent, straight to decurved hairs, to c. 0.2 mm long. *Leaves* spirally arranged, variably orientated, from steeply antrorse to shallowly retrorse; apex acute, shortly mucronate, non-pungent, the mucro 0.1–0.2 mm long; base attenuate to cuneate; petiole 0.3–0.7 mm long, \pm hairy throughout, or the abaxial surface glabrous; lamina narrowly to broadly obovate or narrowly to broadly elliptic, 3–7.2 mm long, 1.2–2.8 mm wide, from concave adaxially to distinctly convex, longitudinal axis varying from slightly incurved to slightly recurved; surfaces \pm concolorous, or the abaxial surface slightly paler; adaxial surface slightly shiny, sparsely hairy, at least in the lower half, venation obscure; abaxial surface matt, sparsely hairy, with 5–7 primary veins, rather narrowly grooved between the veins; margins obviously ciliate on younger leaves with hairs to 0.1 mm long. *Inflorescence* axillary, erect, usually 1-flowered, less often up to 4-flowered, axis 0.2–1.0 mm long when 1-flowered (up to at least 3 mm long if multi-flowered, but mature multi-flowered inflorescences not seen), \pm terete, with a dense indumentum, bud-rudiment absent in 1-flowered inflorescences, but usually present when multi-flowered; flowers erect, sessile above the bracteoles. *Fertile bracts* present only in multi-flowered inflorescences, narrowly ovate, c. 1 mm long and 0.5 mm wide, sterile bracts absent. *Bracteoles* narrowly ovate, 1.1–1.8 mm long, 0.5–0.6 mm wide, attenuate; abaxial surface with spreading hairs; margins ciliate. *Sepals* narrowly ovate, 2.2–3.0 mm long, 0.6–0.7 mm wide, long-attenuate, the apices filiform, \pm recurved; abaxial surface pale green, with a sparse to moderately dense indumentum of spreading hairs, venation obscure to well-defined (refer notes below); adaxial surface with a few hairs towards apex and sometimes also at the base; margins ciliate with hairs to c. 0.1 mm long. *Corolla tube* white, narrowly ellipsoid, shorter than the sepals, 1.5–2.2 mm long, 1.0–1.3 mm wide, glabrous externally, internal surface with an apical band of hairs, otherwise glabrous. *Corolla lobes* white, usually longer than, or occasionally \pm equal to the tube, 2.0–2.5 mm long, 0.5–0.6 mm wide at base, erect in the lower 1/3–1/2 and then spreading and recurved, glabrous externally, internal surface with a dense indumentum of \pm terete, ornamented hairs. *Filaments* terete, 0.4–0.5 mm long, attached to anther 3/4 above anther base, or a little above, adnate to tube just below sinuses. *Anthers* partially exserted from the tube (by 1/3–2/3 of their length), 0.7–1.1 mm long, apex shallowly emarginate. *Nectary* partite, the scales 0.3–0.4 mm long, 0.2–0.3 mm wide, glabrous. *Ovary* whitish-green, narrowly ovate in outline, 0.6–0.8 mm long, 0.3–0.4 mm wide, glabrous, 2-locular, slightly compressed. *Style* 1.5–2.2 mm long, minutely scabrous in the upper half, glabrous below, arising from a depression at the ovary apex that tightly envelops, but is free from, the style base (i.e. the base is countersunk below the level of the ovary apex), exserted from corolla tube to a point a little above the anther apices; stigma distinctly expanded. *Fruit* narrowly obovate to narrowly elliptic in outline, 4.5–5.0 mm long (inclusive of gynophore), 1.7–2.0 mm wide, much longer than the sepals, strongly compressed (linear to very narrowly elliptic in TS), with a glabrous gynophore; surface dry, with 5–7 raised longitudinal veins; style early deciduous. (Figure 4)

Diagnostic characters. Within the *S. blepharolepis* group (or Group XI *sensu* Puente-Lelièvre *et al.* 2016) distinguished by the following combination of characters: leaves narrowly to broadly obovate to narrowly to broadly elliptic with attenuate to cuneate bases; leaf apex shortly mucronate, the mucro

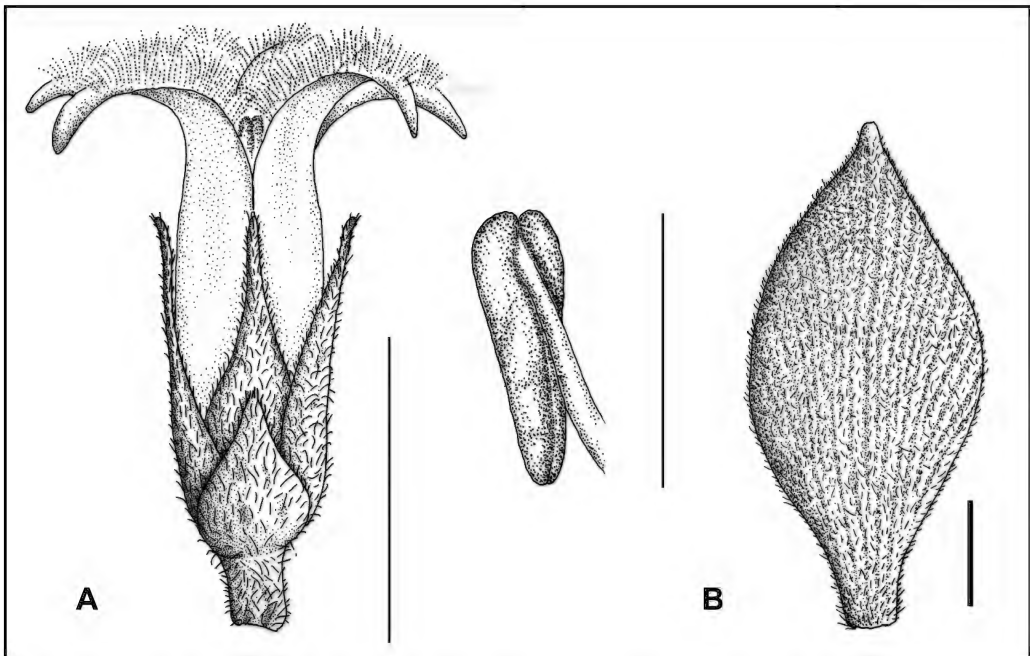


Figure 4. *Styphelia blackallii*. A – 1-flowered inflorescence, stamen; B – leaf, abaxial view. Scale bars: A = 2 mm (inflorescence), 0.8 mm (stamen); B = 1 mm. Voucher *M. Hislop* 4787. Drawings by Skye Coffey.

0.1–0.2 mm long, non-pungent; sepals hairy, long-attenuate, at least as long as the corolla tube, with filiform ± recurved apices; nectary scales glabrous; gynophore glabrous.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 11 Nov. 1931, *W.E. Blackall* 1315 (PERTH); 12 Dec. 2018, *M. Hislop* 4787 (HO, K, PERTH).

Distribution and habitat. Known with certainty only from the Tarin Rock area, west of Lake Grace, in the far west of the Mallee bioregion. At the type locality the plant is growing in heath and open mallee woodland in white or very pale-yellow sand. Associated species include *Eucalyptus dorrienii*, *Eremaea pauciflora*, *Melaleuca subtrigona*, *Leptospermum roei* and *Petrophile ericifolia*.

Phenology. The only collections so far have been made in November and December and peak flowering is likely to be in late spring and early summer. However, in common with other members of the *Styphelia blepharolepis* group some flowers and/or fruit are likely to be present for much of the year.

Etymology. The epithet honours the major contribution made by William Edward Blackall (1876–1941) towards a better understanding and appreciation of the highly diverse flora of south-western Australia. Although he did not live to see his project to publish illustrated keys to Western Australian plant families come to fruition, it was taken up after his death by the late Brian Grieve, then professor of botany at the University of Western Australia. The resultant series of books, *How to Know Western Australian Wildflowers* (1954–1998), have been the primary introduction to the Western Australian flora for thousands of plant enthusiasts (amateur and professional alike) ever since.

The name is also appropriate because until its rediscovery in 2018, this species was only known from Blackall's 1931 collection.

Conservation status. Currently listed as Priority Two under Conservation Codes for Western Australian Flora under the name *Styphelia* sp. Tarin Rock (W.E. Blackall 1315) (Western Australian Herbarium 1998–). Since its original listing the species has been rediscovered by botanist Jolanda Keeble, during survey work of nature reserves in the Tarin Rock area. However, it is still only known with certainty from a single restricted population, albeit a healthy one consisting of reasonably good plant numbers.

Affinities. Based on a highly distinctive combination of morphological characters, *S. blackallii* can be confidently assigned to the small *S. blepharolepis* group. This group is characterised in large part by a strongly compressed, prominently veined fruit, partite nectaries, and 2-locular ovaries. It keys out at the first lead of couplet 17 in the recently published interim key to the species groups of Western Australia *Styphelia* (Hislop 2021).

Within the *S. blepharolepis* group, *S. blackallii* is morphologically most similar to *S. capillaris* Hislop & Puente-Lel., another rare species from the Darling Range south-west of York. The two are assumed to be close relatives and share a distinctive sepal character in which the apices are long-attenuate and filiform. *Styphelia blackallii* differs from *S. capillaris* in the following ways: leaves (on the same plant) narrowly to broadly obovate to narrowly to broadly elliptic with an attenuate to cuneate base (*cf.* narrowly ovate to narrowly elliptic with a cuneate to rounded base in *S. capillaris*); petioles well-defined, 0.3–0.7 mm long (*cf.* poorly defined, 0.1–0.3 mm long); sepals hairy (*cf.* glabrous).

Notes. There are some noteworthy differences between the Blackall collection and those from the type locality even though Blackall's notes make it clear that they were collected within a few kilometres of each other. In comparison to plants at the type locality, *Blackall* 1315 has leaves that are thicker and tending to be narrower. In addition, the inflorescences are largely restricted to the axils of bract-like, 'early seasonal leaves' (*sensu* Powell *et al.* 1997: 16) rather than regular, mature leaves, the sepal venation is more prominent and the anthers less exerted from the corolla tubes. The significance of these differences is difficult to judge given the very small sample size, but pending the discovery of additional populations, the two morphotypes are assumed to represent infraspecific variation only.

In late October 2021 the author collected a plant (*M. Hislop* 4876) belonging to the *S. blepharolepis* group from a nature reserve about 50 km to the west of the type population of *S. blackallii*. While the material is closer to *S. blackallii* than to any other known member of the group it differs in several ways that may be taxonomically significant. Compared to *S. blackallii* the leaves of *M. Hislop* 4876 are broader (to 4 mm wide *cf.* to 2.8 mm in *S. blackallii*) and the apex is a very short and broad callus tip rather than being clearly mucronate, with a 0.1–0.2 mm long mucro. The sepals and corollas are also generally larger: sepals 1.2 mm wide (*cf.* 0.6–0.7 mm wide); corolla tube 2.5 mm long by 1.8 mm wide (*cf.* 1.5–2.2 mm by 1.0–1.3 mm). In addition, while both *S. capillaris* and *S. blackallii* grow in deep, white or very pale-yellow sand, *M. Hislop* 4876 was growing in grey clay-loam. Unfortunately, despite a lengthy search only a single specimen was found at the new locality and so at this stage there is no way of knowing how representative it is of plants in the area more generally. In these circumstances it has not been included in the above description and will be referred to *S. aff. blackallii*, pending the availability of further collections.

Acknowledgements

I am very grateful to Damien Rathbone, Sarah Barrett, and Megan Dilly, without whose contributions I would not have been in a position to describe *Dielsiodoxa altimontana*. Similarly, without the fruitful search effort of Jolanda Keeble the status of *Styphelia blackallii* may well have remained in abeyance.

I would also like to thank Skye Coffey for the excellent illustrations, the vigilant Dave Albrecht who in his capacity as reviewer highlighted some inconsistencies between the descriptions and the illustrations, and Kelly Shepherd who helped to remedy those inconsistencies.

References

- Albrecht, D.E. & Hislop, M. (2011). A revision of *Dielsiodoxa* (Ericaceae: Styphelioideae: Oligarrheneae). *Nuytsia* 21: 107–126.
- Blackall, W.E. & Grieve, B.J. (1954–1998). How to know Western Australian Wildflowers (University of Western Australia Press: Nedlands.)
- Hislop, M. (2013). A taxonomic update of *Conostephium* (Ericaceae: Styphelioideae: Styphelieae). *Nuytsia* 23: 313–335.
- Hislop, M. (2021). Interim key to, and composition of, species groups in Western Australian *Styphelia*. *Nuytsia* 32: 29–37.
- Powell, J.M., Morrison, D.A., Gadek, P.A., Crayn, D.M. & Quinn, C.J. (1997). Relationships and generic concepts within Styphelieae (Epacridaceae). *Australian Systematic Botany* 10: 15–29.
- Puente-Lelièvre, C., Hislop, M., Harrington, M., Brown, E.A., Kuzmina, M. & Crayn, D.M. (2016). A five-marker molecular phylogeny of the Styphelieae (Epacridoideae, Ericaceae) supports a broad concept of *Styphelia*. *Australian Systematic Botany* 28: 368–387.
- Western Australian Herbarium (1998–). *Florabase—the Western Australian Flora*. Department of Biodiversity, Conservation and Attractions. <https://florabase.dbca.wa.gov.au/> [accessed 21 April 2022]

***Eriochilus glareosus* (Orchidaceae), a new species from
south-west Western Australia**

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SHORT COMMUNICATION

Eriochilus glareosus G.Brockman & C.J.French, *sp. nov.*

Type: Roleystone, Western Australia [precise locality withheld for conservation reasons], 12 June 2004, *G. Brockman* 1147 (*holo:* PERTH 06963986; *iso:* CANB).

Eriochilus sp. Roleystone (G. Brockman 1140), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 6 July 2022].

Terrestrial tuberous *herb* 6–12 cm tall. *Leaf* single, 6–20 mm long × 5–10 mm wide, arising from the scape at around one third of the scape height, sometimes not fully developed at anthesis and clasping the scape, ovate, entire, with an acute tip, bi-colourous, dark green above and deep purple or greenish purple and sparsely ciliate below. *Scape* 50–100 mm tall × 1–1.2 mm thick, wiry, maroon and sparsely ciliate below the leaf, maroon/green and glabrous above the leaf. *Ovary* 7–9 mm long × 1.5–2 mm wide, longitudinally ridged, glandular, green. *Flowers* 1–2(3), 13–15 mm long × 7–9 mm wide, upright, white with purple markings on the labellum, white lateral sepals and brown shades in other segments; flowers emit a strong sweet honey odour. *Dorsal sepal* 6–7.5 mm long × 2–2.5 mm wide, slanted obliquely forward over the column, spatulate, entire, apex subacute, margins and dorsum sparsely ciliate, greenish brown. *Lateral sepals* 8–11 mm long × 2.5–3 mm wide, projecting from beneath labellum, spreading, obliquely down and forward, narrowly elliptic, white with sparse ciliate margins becoming denser distally. *Petals* 5–6 mm long × 0.5–0.8 mm wide, projecting forward often obliquely down, distally turned in and mildly flared, ciliate, linear, greenish brown. *Labellum* 7–9 mm long × 2.5–3 mm wide at the widest point, appressed to the column upward and forward in the proximal one quarter, then forward before curving down and back through 180°; proximal one third oblong, transversely concave, with short lateral lobes, 0.5–0.75 mm high, upright and translucent, callus flattened, 0.7 mm wide × 1–1.5 mm long, green, shortly ciliate; distal two thirds ovate and thickened and covered with clumps of maroon and white cilia to 1.2 mm long. *Column* 5–5.5 mm long × 1.2–1.5 mm wide, held erect from the ovary, thickened centrally, 0.8–1 mm throughout; column wings 0.5 mm; anterior opening 1–1.3 mm wide × 0.5–0.6 mm deep, obscurely horizontally oval, margins cream with maroon markings. *Anther* 1–1.2 mm long × 1.2–1.5 mm wide, ovate, margins irregular and glandular, yellow/brown with purple margins. *Pollinium* in two sets of four, individually

1.0–1.2 mm long \times 0.3–4 mm wide, clavate, bright yellow. *Stigma* translucent, scutiform, elliptical, 1.5–1.8 mm \times c. 1 mm. *Capsule* not seen. (Figure 1)

Diagnostic features. *Eriochilus glareosus* can be distinguished from all other members of the genus by the following combination of characters: small statured herb up to 12 cm tall, one or two small flowers (rarely 3) with narrow labella (2.5–3 mm wide at the widest point), widely spreading petals and an entire, ovate leaf, dark green above, deep purple or greenish purple and sparsely ciliate below.

Selected specimens. WESTERN AUSTRALIA: [localities withheld for conservation reasons], 12 June 2004, G. Brockman 1146 (PERTH); 12 June 2004, G. Brockman 1140 (PERTH); 3 June 2021, G. Brockman 4094 (PERTH); 3 June 2021, G. Brockman 4092 (PERTH).

Phenology. Flowering occurs from June through July.

Distribution and habitat. A seldom seen species currently known from only five close locations in the Perth Hills area of Roleystone – Martin. It occurs in scattered numbers within populations, in and around disturbed habitat in Jarrah and Casuarina woodlands on laterite. It is most commonly found in and around open revegetated gravel reserves. Response to fire is uncertain.

Conservation status. This species is poorly known and currently listed as Priority One under Conservation Codes for Western Australian Flora, under the name *E. sp.* Roleystone (G. Brockman 1140) (Western Australian Herbarium 1998–). Conserved in regional parkland; however, this species is threatened by recreational vehicle activities, illegal firewood collection, fire mitigation programs (track widening), and illegal rubbish dumping.

Etymology. The specific epithet is from the Latin *glareosus* (pertaining to gravel), alluding to the preferred habitat of the species.

Common name. Scarp bunny orchid.

Affinities. *Eriochilus glareosus* is most similar to *E. helonomos* Hopper & A.P.Br. in having a short stature, one or two flowers and a small leaf. However, *E. glareosus* can be readily distinguished from *E. helonomos* by its smaller flower size (13–15 mm long *cf.* 17–19 mm long), with a narrower labellum (2.5–3 mm wide *cf.* 4–4.5 mm wide) and spreading petals (vs clasping the column). The leaves in *E. glareosus* are also wider than *E. helonomos* (5–10 mm *cf.* 3–7 mm) and ovate rather than cordate, with a deep purple or greenish purple underside (vs green). *Eriochilus helonomos* also prefers a damp habitat as opposed to the well-drained habitat of the new species.

Eriochilus glareosus grows sympatrically with *E. dilatatus* Lindl. subsp. *dilatatus* and it is easily distinguished from this subspecies by its shorter scapes (5–12 cm *cf.* 7–52 cm), fewer flowers (1–2 *cf.* 1–20) that are narrower (7–9 mm *cf.* 12–20 mm) with a narrower labellum (2.5–3 mm wide *cf.* 3–5 mm), and a smaller leaf (6–20 mm \times 5–10 mm *cf.* 5–30 mm \times 10–60 mm), which is light green on both surfaces in *E. dilatatus* subsp. *dilatatus*.

The distribution of *Eriochilus glareosus* does not overlap that of *E. dilatatus* Lindl. subsp. *brevifolius* (Benth.) Hopper & A.P.Br. It is distinguished from this subspecies by its shorter scapes (5–12 cm *cf.* 5–28 cm), fewer flowers (1–2(3) *cf.* 1–5) that are narrower (7–9 mm *cf.* 10–15 mm), with a narrower



Figure 1. *Eriochilus glareosus*. A – close up of a flower; B – plant *in situ*; C – close up of leaf underside, plant *in situ*. From the type locality in Roleystone, Western Australia. Voucher: G. Brockman 4092 (PERTH). Photographs Garry Brockman.

labellum (2.5–3 mm wide *cf.* 3–5 mm), and a smaller leaf (6–20 mm \times 5–10 mm *cf.* 4–32 mm \times 2–11 mm), with entire margins (wavy for *E. dilatatus* subsp. *brevifolius*).

Eriochilus glareosus flowers later than *E. dilatatus* subsp. *dilatatus*, which is in fruit when *E. glareosus* is in full flower. *Eriochilus glareosus* usually flowers later than *E. helonomos*; however, sometimes there is overlap in unseasonably wet conditions when the flowering period of *E. helonomos* is extended.

Notes. This new species shows an apparent preference for disturbed environments where it flowers freely; however, it has also been found in undisturbed locations following a summer fire. The build-up of general forest litter makes it very difficult to relocate in unburned forest.

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Three new Western Australian species related to *Calytrix violacea* (Myrtaceae: Chamelaucieae)

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SHORT COMMUNICATION

Calytrix Labill. (Myrtaceae: Chamelaucieae DC.) comprises at least 90 species and is widely distributed in Australia, with most species in south-west Western Australia and with secondary centres of species diversity in the monsoon tropics and eastern Australia. Most members of the genus are distinctive in having a long, slender awn terminating each sepal. Some species that lack, or have very reduced, awns were initially placed in *Lhotskya* Schauer, while one species with no sepals at all was placed in *Calythropsis* C.A.Gardner. Craven (1987) reduced *Lhotskya* to synonymy under *Calytrix* on the basis that there was an intergradation in sepal characters between the two genera, and subsequently (Craven 1990) also included *Calythropsis* in *Calytrix*. All species previously included in *Lhotskya* or *Calythropsis* (i.e. species without sepal awns) were placed by Craven (1987, 1990) into four informally recognised species-groups, three of which also contained distinctly awned species. The larger species groups were further subdivided into ‘alliances’.

Later publications (Keighery 2004; Barrett *et al.* 2009; Rye 2013, 2020; Nge *et al.* 2017) have resulted in the reinstatement of two old species, description of seven new species, and recognition of further informal species alliances. Several additional known or putative species have phrase names or are still awaiting the allocation of phrase names.

The current paper began with a recently discovered, awnless *Calytrix* population from the Cape Riche area on the south coast of Western Australia, which was regarded as likely to be a new species and phrase-named at the Western Australian Herbarium as *Calytrix* sp. Cape Riche (G.J. & B.J. Keighery 2934). Initial morphological examinations indicated that it was morphologically closest to members of the more or less awnless *C. violacea* (Lindl.) Craven species group, which, in Craven (1987), also included *C. acutifolia* (Lindl.) Craven, *C. merrelliana* (F.Muell. & Tate) Craven, *C. nematoclada* Craven and *C. parvivalis* Craven. The white-flowered *C. acutifolia* was regarded by Craven (1987) as an anomalous species in this group. Nge *et al.* (2021) provided the first comprehensive molecular phylogeny of the genus and confirmed that *C. acutifolia* is phylogenetically distant from other members of the *C. violacea* species-group. Most of the species-groups of Craven (1987) were not retrieved in the

phylogeny, including the *C. violacea* species-group. A future revised classification (which is currently pending further targeted research) could reduce the *C. violacea* species-group to fewer species or expand it to include 14 drawn from several of Craven's informal species-groups.

Given that a comprehensive molecular phylogeny exists, we sequenced the new *Calytrix* to assess its phylogenetic placement within the genus. Sampling, laboratory preparation, sequencing, and downstream phylogenetic analyses follow those adopted by Nge *et al.* (2021; including Supplementary Material). Due to a low DNA yield which may have resulted in sub-optimal sequencing, only 18 of the original 28 nuclear loci were successfully recovered from the Cape Riche specimen. The final alignment for this study included all other sequenced *Calytrix* species from Nge *et al.* (2012), but only 18 nuclear loci instead of the full 28, as it has been shown that missing sequence data can bias phylogenetic reconstructions (e.g. Smith *et al.* 2020). A maximum likelihood phylogeny (Figure 1) was generated using RAXML v. 8.2.10 (Stamatakis 2014), with the GTR+I+G nucleotide substitution model (see Abadi *et al.* 2019) and 100 regular bootstrap support replicates.

Our RAXML phylogeny presented here confirmed that the *Calytrix* sp. Cape Riche (G.J. & B.J. Keighery 2934) sample is closely related to *C. violacea*, placing it as sister to a sample of *C. violacea* (FN 612, AD284792) from near Wongan Hills, albeit with marginal bootstrap support (BS = 64). There is some indication from Figure 1 and Nge *et al.* (2021) that *C. violacea* may be polyphyletic, but support values are too low to make firm conclusions. The other *C. violacea* sample in the phylogeny (FN 424, AD205163) was collected from Kellerberrin and is likely to be another one of the new species that we are describing here (*C. mucronata*), instead of *C. violacea* s. str. However, an examination of the specimen is required to confirm this.

Detailed morphological examination indicated that the Cape Riche population is distinct from all other collections of *C. violacea*, from which it is also widely disjunct both geographically and ecologically. Further, close examination of all available herbarium material of *C. violacea* at PERTH, while dealing with the Cape Riche taxon, showed that it is polytypic and readily separable into three taxa differing in leaf length, indumentum and apex shape, flower size, and the size, shape and distribution of floral bracts.

Accordingly, we here describe the three new species *Calytrix djinda* Keighery & Rye, *C. mucronulata* K.R.Thiele and *C. ryeae* K.R.Thiele, and re-circumscribe *C. violacea*. Distributions of all four taxa are given in Figure 2, and a key to the species in *C. violacea* s. lat. provided.

Key to species segregated from *Calytrix violacea* s. lat.

1. Inflorescences elongate, without a distinct involucre of subtending empty floral bracts (Cape Riche area) ***C. djinda***
- 1: Inflorescences usually contracted and head-like (sometimes somewhat elongate), with a distinct involucre of few to many subtending empty floral bracts (widespread in the Wheatbelt extending to the Goldfields; not on the South Coast)
 2. Leaves (4–)5–10 mm long, flattish (not deeply concavo-convex), obtuse; flowers 12–15 mm diam.; floral bracts broadly ovate to orbicular, obtuse, 3–7 mm long ***C. violacea***
 - 2: Leaves (2–)3–5(–6) mm long, deeply concavo-convex, distinctly though minutely mucronulate; flowers 8–12 mm diam.; floral bracts ovate to triangular, acute to acuminate, 1.8–4 mm long

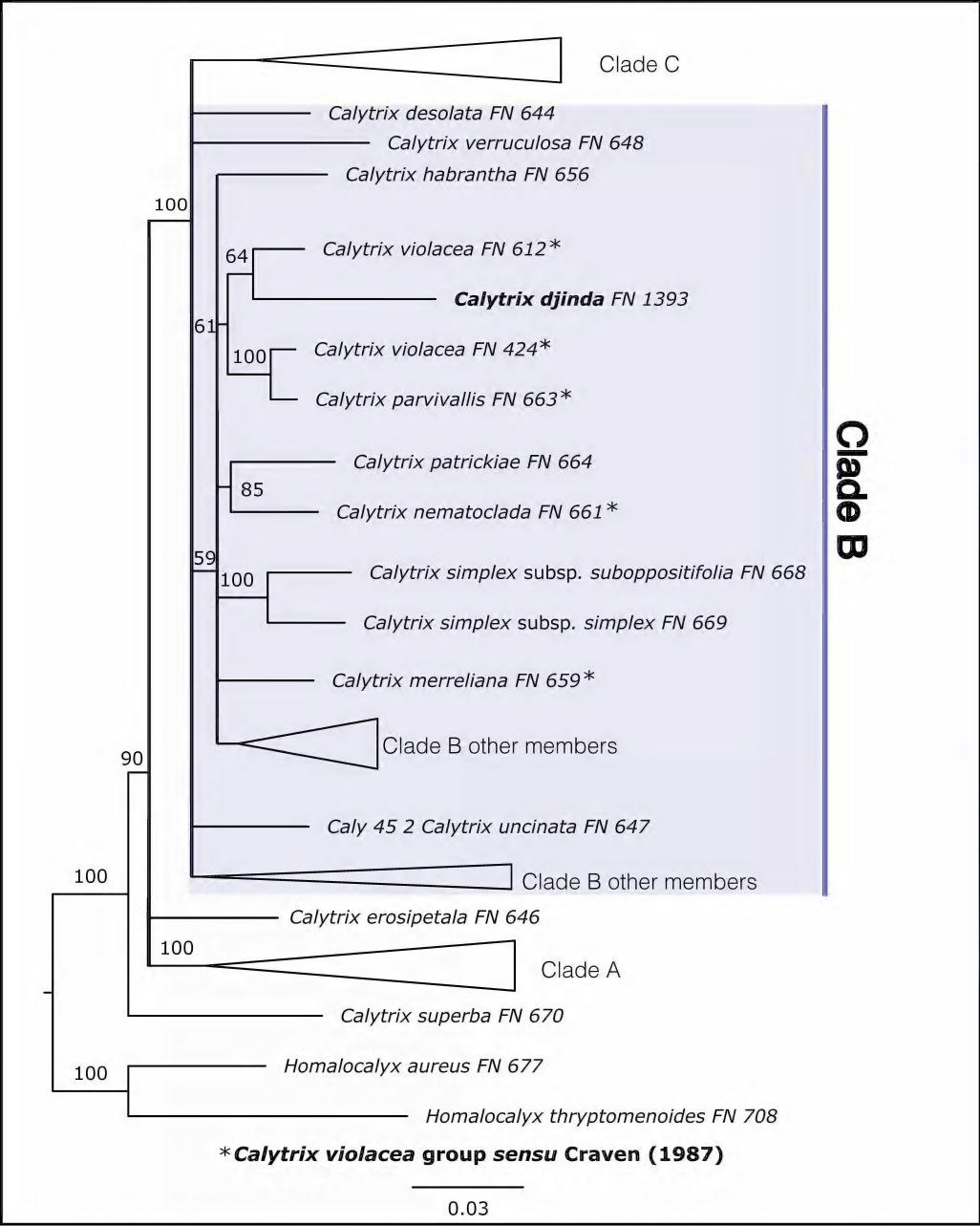


Figure 1. Phylogenetic relationships of *Calytrix* inferred from Maximum Likelihood (RAxML) analysis of 18 nuclear loci. Bootstrap support values ≥ 50 are displayed for each node; nodes with lower support values are collapsed. Asterisks indicate the *Calytrix violacea* group sensu Craven (1987). *Calytrix djinda* is highlighted in bold. Clade B is highlighted in blue. Other clades are collapsed and labelled following the clades (A, B, C) of Nge *et al.* (2021).

3. Leaves with an even indumentum of short, \pm straight, patent hairs; inflorescences axis usually determinate (Goldfields).....**C. ryeae**
- 3: Leaf indumentum variable, comprising short to long, usually curved hairs that are often restricted to the adaxial surface or the lateral angles of the lamina; inflorescence axis usually growing on after flowering (Wheatbelt)**C. mucronulatum**

Calytrix djinda* Keighery & Rye, *sp. nov.

Type: Cape Riche, Western Australia [precise locality withheld for conservation reasons], 29 October 2013, G.J. Keighery & B.J. Keighery 2934 (*holo:* PERTH 09196250; *iso:* CANB, K, MEL).

Calytrix sp. Cape Riche (G.J. & B.J. Keighery 2934), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 8 March 2022].

Shrubs c. 0.5 m tall \times 0.3 m wide. *Young stems* sparsely pubescent with patent hairs 0.1–0.2(–0.4) mm long. *Leaves* alternate (sometimes partially sub-opposite), antrorse to spreading, scattered along the stems and often widely spaced; *petiole* 0.5–1 mm long, with indumentum as for the stems and leaves; *colleters* (‘stipules’) to 0.3 mm, filiform, pale to dark (deciduous or apparently absent on many leaves); *lamina* linear to very narrowly obovate, 4–7 mm long, 0.5–1 mm wide, straight, sparsely pilose with spreading, flexuose hairs to 0.5 mm long; abaxial surface deeply convex, carinate; adaxial surface flat to shallowly concave with a distinct, raised rib along the midline; apex acute to minutely apiculate, the apiculum glabrous to (rarely) sparsely hairy, \pm straight to slightly inflexed; *oil glands* inconspicuous, pale. *Inflorescences* raceme-like, subterminal, 15–35 mm long, with flowers borne at 8–15 consecutive axils, the axis continuing growth before flowering, with the uppermost fertile axil 5–20 mm below the shoot apex; *floral bracts* c. 4 mm long, ovate to elliptic, acute, concavo-convex, keeled, narrowly to broadly scarious-margined, moderately pilose with flexuose, white hairs to 0.7 mm long, a few basal ones sometimes empty (not subtending a flower) but not forming a distinct involucre. *Peduncles* 0.7–1.5 mm long. *Bracteoles* shortly connate at base to form a slightly compressed, funnel-shaped cheiridium 3–3.5 mm long, each with a narrowly triangular central green portion that is sometimes excurrent to 0.2 mm and has spreading hairs, and broad, translucent wings that are glabrous except for minute to long cilia towards the apex. *Flowers* 10–12 mm diam. *Hypanthium* not produced above the ovary, narrowly obconic, c. 3 mm long, c. 1 mm wide, not exceeding the cheiridium, 10-ribbed, moderately to densely white-pubescent, the hairs to c. 0.5 mm long, appressed at first becoming more spreading in fruit. *Sepals* very broadly or depressed-obovate, usually emarginate, 1–1.5 mm long, 1.3–1.8 mm wide, moderately hairy outside on the herbaceous part, glabrous on the broad, scarious margin; awn absent. *Petals* purple (darker at the base), ovate, c. 6 mm long, 2.3–3 mm wide. *Stamens plus staminodes* 53–75, 3- or 4-seriate, with the longest stamens in the outermost series and reduced stamens or staminodes in the innermost series; longest filaments 3.5–4.5 mm long, purple; largest anthers c. 0.3 mm long, yellow. *Ovary* yellowish on the summit; ovules 2. *Style* 4–5 mm long. *Fruits* not seen at maturity but the most mature one examined narrowly obovoid, the hypanthium c. 1.5 mm wide below the calyx and densely pubescent. (Figure 3)

Diagnostic features. Distinguished from *C. violacea* and its other segregates by having flowers borne in a loose raceme-like inflorescence below the vegetative apex of the stem, the base of the inflorescence subtended by a few widely spaced, sterile, leaf-like bracts not forming a distinct involucre.

Specimen examined. Only known from the type specimen.

Phenology. Buds, open flowers and young fruits were present when the type was collected in very late October, so flowering continues into November.

Distribution and habitat. Known from a single location in the Cape Riche area (Figure 2), occurring on seaside cliffs in red loam (possibly over spongolite) in low, wind-pruned heath.

Conservation status. Listed as Priority One under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Calytrix* sp. Cape Riche (G.J. & B.J. Keighery 2934). The single specimen of this species was collected from a large population that is not in a nature reserve.

Etymology. From the Noongar (Minang) language of the Albany region: *djinda* (a star) refers to the star-shaped flowers, and is used as a noun in apposition.

Vernacular name. Cape Riche Starflower.

Notes. *Calytrix djinda* is geographically isolated from the other species of the *C. violacea* group. Most specimens of *C. violacea* and the other segregates dealt with here have dense terminal clusters of flowers subtended by a distinct involucre of leaf-like, empty bracts. A few specimens in the south of the range of *C. mucronulata* (described below) have a somewhat looser, more raceme-like inflorescence, but this is much more condensed than in *C. djinda* and an involucre is always present at the base of the inflorescence in the flowering stage. *Calytrix djinda*, by contrast, lacks an involucre, having instead a few widely spaced, empty floral bracts below the flower-bearing portion. Note that the involucre bracts are often shed in fruiting specimens. However, careful examination of old stems in fruiting specimens will reveal short sections of stem at the base of growth units (*C. violacea*, *C. mucronulata*) or peg-like, dead stubs (i.e., the stems not growing on; *C. ryeae*) with numerous scars left when the involucre leaves and flowers were shed; these are not present in *C. djinda*.

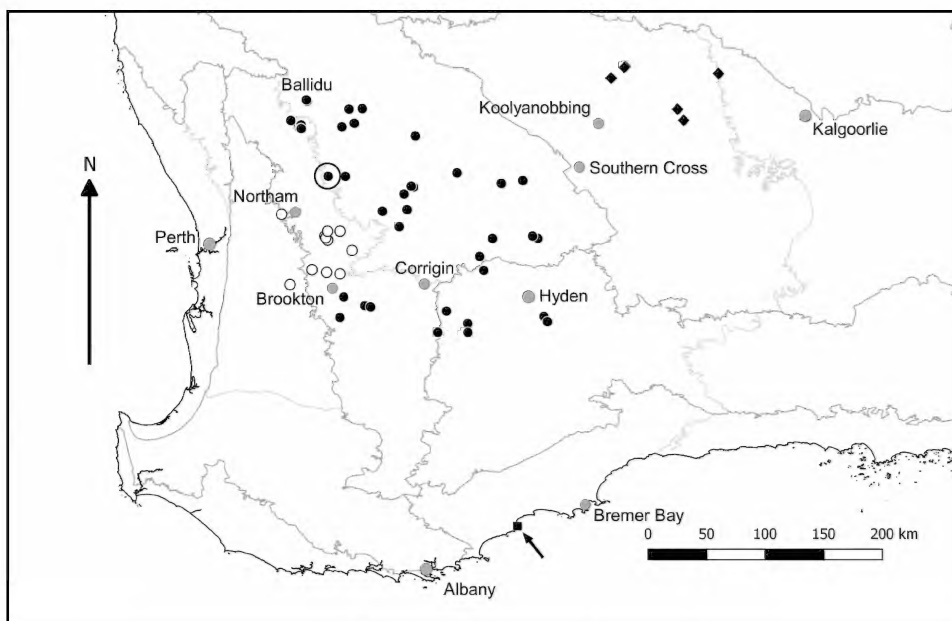


Figure 2. Distributions of *Calytrix djinda* (■; arrowed), *C. mucronulata* (●), *C. ryeae* (◆) and *C. violacea* (○) in Western Australia. The location of a mixed population of *C. mucronulata* and *C. violacea* is circled.

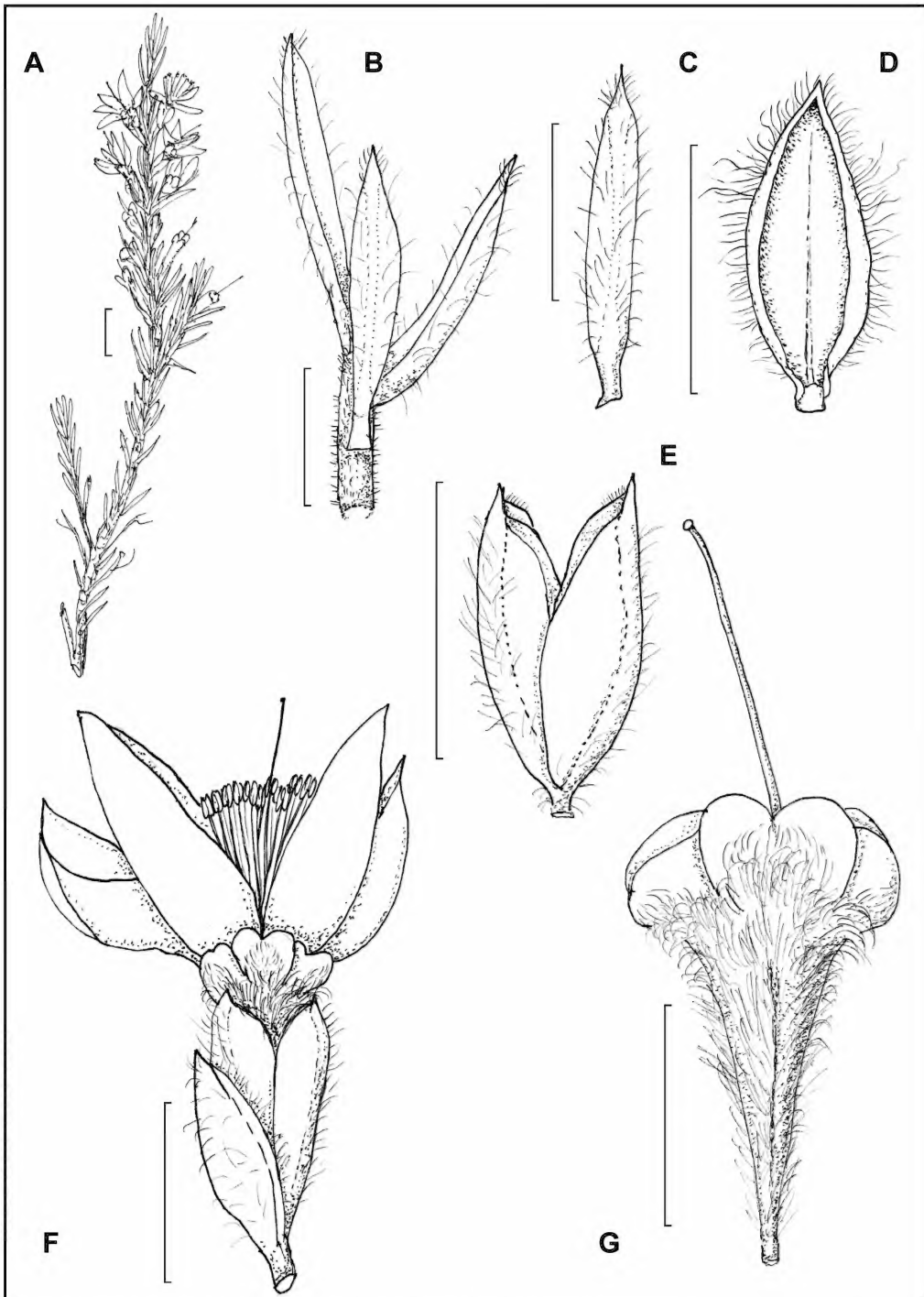


Figure 3. *Calytrix djinda*. A – flowering branch; B – leaves showing alternate arrangement; C – abaxial view of leaf; D – floral bract, showing the glabrous adaxial surface and densely ciliate margins; E – two bracteoles shortly united to form a cheiridium; F – flower subtended by a floral bract and cheiridium, showing the longest stamens (shorter stamens hidden from view); G – young fruit. Scale bars: 5 mm (A), 3 mm (B–H). Drawn by G.J. Keighery (A–C & E–G) and B.L. Rye (D) from G.J. Keighery & B.J. Keighery 2934 (A–G).

Calytrix mucronulata* K.R.Thiele, *sp. nov.

Type: Hindmarsh Rifle Range, Western Australia, 25 October 1987, *B.H. Smith* 1003 (*holo:* PERTH 03565823; *iso:* CANB, MEL).

Erect to spreading, often dwarf *shrubs* to 0.4(–1) m high. *Young stems* sparsely to moderately pubescent (rarely villous) with patent, straight to flexuose, greyish to pale fawn hairs 0.1–0.3(–0.5) mm long. *Leaves* alternate, spreading, rather crowded on younger branchlets; *petiole* 0.4–0.5 mm long, glabrous or sparsely to moderately minutely pubescent; *colleters* (‘stipules’) 0.3–1 mm long, filiform to acicular, pale to dark; *lamina* narrowly obovate, (2–)3–5(–6) mm long, 0.6–1.2 mm wide, straight to slightly incurved, sparsely to moderately and finely pubescent to (rarely) hispid or villous with patent to spreading, straight to curved (or rarely flexuose) hairs 0.2–1 mm long sometimes restricted to the adaxial surface or lateral angle; abaxial surface deeply convex, obscurely to prominently carinate; adaxial surface shallowly to distinctly concave, sometimes with a narrow, raised rib along the midline; apex acute to apiculate, the apiculum glabrous to (rarely) sparsely hairy, usually slightly inflexed; *oil glands* not prominent, pale to (rarely) dark. *Inflorescences* comprising 5–25 flowers on an axis 5–20 mm long, condensed to somewhat elongate (and then with the flowers crowded), terminating growth units and with the axis continuing growth after flowering (indicated by distinct, short segments of older stems bearing scars from the flowers and inflorescence-subtending floral bracts); *floral bracts* 1.8–4 mm long, narrowly ovate to ovate, acute to acuminate, flattened to concavo-convex, keeled, scarious- and ciliate-margined, glabrous to moderately pubescent, the 10–30 lowermost ones without flowers and forming a \pm distinct involucre subtending the inflorescence. *Peduncles* to 1.2 mm long. *Bracteoles* shortly connate at base to form a slightly compressed, funnel-shaped cheiridium 3–3.6 mm long, each with a narrowly triangular central green portion excurrent to 0.2 mm and with short, patent hairs, and broad, translucent wings that are glabrous except for minute to long cilia towards the apex. *Flowers* 8–12 mm diam. *Hypanthium* not produced above the ovary, narrowly obconic, 2.4–3.5 mm long, *c.* 1 mm wide, not exceeding the cheiridium, 10-ribbed, densely white-pubescent, the hairs to *c.* 0.3 mm long, appressed at first becoming more spreading in fruit. *Sepals* orbicular to transversely elliptic, often emarginate, 1.2–1.8 mm long, 1.3–1.8 mm wide, densely hairy outside on the herbaceous part, glabrous on the broad, scarious margin; awn absent. *Petals* purple (darker at the base), ovate, 4.5–5.5 mm long, 2.2–3 mm wide. *Stamens plus staminodes* 32–45, 3- or 4-seriate, with the longest stamens in the outermost series and reduced stamens or staminodes in the innermost series; longest filaments 3.5–4 mm long, purple; largest anthers *c.* 0.3 mm long, yellow. *Ovary* yellowish on the summit; ovules 2. *Style* 3.5–4 mm long. *Fruits* 2.5–4 mm long, densely pubescent, the narrowly obconical hypanthium *c.* 1.5 mm wide below the calyx.

Diagnostic features. Distinguished from the other species segregated from *C. violacea* by the following combination of characters: leaves short (the lamina usually 3–5 mm long), deeply concavo-convex, apiculate, usually with an indumentum of short, patent hairs often restricted to, or more dense on, the adaxial surface and angles; inflorescences comprising 5–25 flowers, forming a contracted head with the axis growing on after flowering; floral bracts 1.8–4 mm long, ovate-acute, the 10–30 lowermost ones without flowers and forming a \pm distinct involucre subtending the inflorescence; hypanthium not exceeding the cheiridium.

Chromosome number. $2n = c. 22$ (Rye 1979; as *Wehlia sp. aff. coarctata* F.Muell.), voucher: *B.L. Powell* 73086.

Selected specimens examined. WESTERN AUSTRALIA: near Narembeen which is S of Merredin, Sep. 1929, *W.E. Blackall s.n.* (PERTH); Mount Caroline Nature Reserve, S of Kellerberrin, SE area of Reserve, near base of granite outcrop, 1 Oct. 2015, *J. Borger* MC 0110-6 (PERTH); Water Reserve

No. 16418 adjacent to the Wongan Hills townsite, site W3, 22 Sep. 1991, *A.M. Coates* 2924 (PERTH); Dragon Rocks Nature Reserve No. 36128, NE section, eastern boundary N of Jilakin Rocks Rd, 25 Oct. 1991, *A.M. Coates* 3324 (PERTH); No. 2 Rabbit Proof Fence road junction with Cadoux-Koorda Rd, 18 Sep. 1985, *B.J. Conn* 2236 (PERTH); 9 km NW of Kulin on the Corrigin Rd, 23 Oct. 1981, *L.A. Craven* 7288 (PERTH); 6 km N of Popanyinning on the Pingelly Rd, 8 Nov. 1981, *L.A. Craven* 7439 (PERTH); 10 km E of South Kuminin on the Kuminin E Rd, 4 Nov. 1992, *L.A. Craven, F.A. Zich & A.M. Lyne* 9008 (PERTH); Manmanning, Avon District, 24 Sep. 1931, *C.A. Gardner* 2730 (PERTH); Quadrat 9 Hutchy's Block, Cardiff Pastoral Co., Hammond Rd, Wyalkatchem, c. 24 km ESE of the Wyalkatchem Townsite, 16 Sep. 2000, *C. Keating et al.* WYCH 9/33 (PERTH); Kellerberrin, Sep. 1897, *R.B. Leake s.n.* (PERTH); SWATT Sandplain Survey, UCL (Unallocated Crown Land), survey site SWA0403C, c. 63.13 km N (2.46 degrees) of Hyden and c. 51.51 km NW (66.56 degrees) of Narembeen, 13 Oct. 2013, *R. Meissner & B. Bayliss* 5691 (PERTH) 2 miles N of Wongan Hills, 7 Oct. 1966, *E.M. Scrymgeour* 1568 (PERTH); Kokardine, 28 Aug. 1984, *B.H. Smith* 417 (PERTH); Koorda North Rd, Water Reserve 9231, NW of Koorda, 10 Sep. 1995, *D.E. True* 8230 (PERTH); 20 km N of Trayning, 11 Aug. 1974, *P.S. Valentine* T 21 (PERTH).

Phenology. Flowers in September and October.

Distribution and habitat. Widespread in the Western Australian wheatbelt, from the vicinity of Ballidu south to Pingelly and east to Dragon Rocks and Walgoolan (Figure 2), occurring in shrub-heaths, mallee shrublands and low woodlands on sandy, gravelly and loamy soils on flats and gentle slopes over granite and laterite, with associated species including *Allocasuarina campestris*, *A. humilis*, *A. spinosissima*, *Banksia attenuata*, *B. prionotes*, *Callitris arenaria*, *Calytrix gracilis*, *Ecdeiocolea monostachya*, *Eucalyptus oldfieldii*, *Grevillea apiculoba*, *G. armigera*, *Hakea incrassata*, *H. trifurcata*, *Leptospermum erubescens*, *Melaleuca leptospermoides*, *M. uncinata* s. lat., *Verticordia roei*, and *Xylomelum angustifolium*.

Conservation status. *Calytrix mucronulata* is widespread and common, and not considered to be under threat.

Etymology. From a diminutive of the Latin *mucronatus* (a sharp point) in reference to the minutely mucronulate leaves and floral bracts.

Notes. *Calytrix mucronulata* is the most common and widespread species among the segregates of *C. violacea* dealt with in this paper. It is best discriminated from the more restricted *C. violacea* s. str. by having shorter leaves that are abaxially deeply convex and mucronulate, and relatively small floral bracts that are narrowly ovate to ovate and acute to acuminate. In true *C. violacea* the leaves are larger, distinctly flatter, and obtuse, and the floral bracts are larger and broadly ovate to orbicular and obtuse. There is also a subtle though useful difference in leaf indumentum, with the hairs in *C. mucronulata* being shorter and straight to curved, while those of *C. violacea* are longer, softer and flexuose.

***Calytrix ryeae* K.R.Thiele, sp. nov.**

Type: unallocated Crown Land, SWATT survey site SWA0704A, c. 72 km west-north-west of Koolyanobbing and c. 91 km west of Coolgardie, Western Australia, 3 October 2016, *E. Leitch & C. Macdonald* WAA 013475 (*holo:* PERTH 09195491).

Erect *shrubs* to 0.35 m high. *Young stems* moderately to densely pubescent with patent greyish hairs c. 0.1 mm long. *Leaves* alternate, spreading, rather crowded at the ends of branchlets; *petiole* 0.4–0.5 mm

long, with indumentum as for the leaves and stems; *colleters* ('stipules') to 0.3 mm, filiform, pale to dark (deciduous or apparently absent on many specimens); *lamina* narrowly obovate, 2.5–5 mm long, 0.6–0.8 mm wide, straight to slightly incurved, moderately and finely pubescent with evenly spaced, patent, straight hairs to 0.1 mm long; abaxial surface deeply convex, not carinate; adaxial surface \pm flat except for a distinct, raised rib along the midline; apex shortly apiculate with a minutely hairy apiculus (rarely broadly acute), \pm straight; *oil glands* prominent, scattered, dark. *Inflorescences* condensed and head-like, comprising (1–)3–6(–10) flowers on an axis 5–10 mm long, terminating growth units and with the axis usually not continuing growth after flowering (older stems with peg-like stubs bearing the scars of floral bracts and flowers); *floral bracts* 2–3 mm long, ovate to triangular, acute, flattened to concavo-convex, keeled and scarious-margined, moderately to densely pubescent, the 3–8 lowermost ones without flowers and forming a \pm distinct involucre subtending the inflorescence. *Peduncles* 0–0.1 mm long. *Bracteoles* shortly connate at base to form a slightly compressed, funnel-shaped cheiridium 3–3.5 mm long, each with a narrowly triangular central green portion with spreading hairs and sometimes excurrent to 0.2 mm, and broad, translucent wings that are glabrous except for minute to long cilia towards the apex. *Flowers* 10–12 mm diam. *Hypanthium* not produced above the ovary, narrowly obconic, 3–3.5 mm long, *c.* 1 mm wide, usually slightly exceeding the cheiridium, 10-ribbed, densely white-pubescent, the hairs to *c.* 0.7 mm long, appressed at first becoming more spreading in fruit. *Sepals* very broadly ovate to depressed-orbicular, not emarginate, 1.2–1.5 mm long, 1.2–1.4 mm wide, densely hairy outside on the herbaceous part, glabrous on the broad, scarious margin; awn absent. *Petals* purple (darker at the base), ovate, 5–5.5 mm long, 2.5–3 mm wide. *Stamens plus staminodes* 25–36, 2- or 3-seriate, with the longest stamens in the outermost series and reduced stamens or staminodes in the innermost series; longest filaments 4–4.5 mm long, purple; largest anthers *c.* 0.25 mm long, yellow. *Ovary* yellowish on the summit; ovules 2. *Style* 4.5–5 mm long. *Fruits* not seen at maturity.

Diagnostic features. Distinguished from other species segregated from *C. violacea* by the following combination of characters: leaves short (the lamina 2.5–5 mm long), deeply concavo-convex, usually minutely apiculate, \pm uniformly covered with very short, patent hairs; inflorescences comprising (1–)3–6(–10) flowers, forming a contracted head with the axis usually not growing on after flowering; floral bracts 2–3 mm long, ovate to triangular, acute, the 3–8 lowermost ones without flowers and forming a \pm distinct involucre subtending the inflorescence; hypanthium usually slightly exceeding the cheiridium.

Specimens examined. WESTERN AUSTRALIA: Credo Conservation Reserve, 17 km WNW of Credo Station homestead, 9 Oct. 2012, *N. Casson* WAA 003074 (PERTH); 16.5 km NE of Bungalbin Hill, 2 Oct. 1991, *R.J. Cranfield* 8143 (PERTH); 10 km NNE of access track to hill E of Bungalbin Hill, 8 Sep. 1989, *R.J. Cranfield & P.J. Spencer* 7785 (PERTH); Helena & Aurora Range to Hunt Range track, 13.25 km NE of Y junction, 6.5 km NE of Bungalbin Hill trig, 47.5 km NNE of Koolyanobbing, 20 Oct. 1990, *F.H. & M.P. Mollemans* 3751 (PERTH); 16 km NE of Bungalbin Hill, 25 Sep. 1982, *K. Newbey* 9609 (PERTH).

Phenology. Flowering specimens have been collected in September and October.

Distribution and habitat. Scattered between the vicinity of the Helena and Aurora Range, East Jaurdi, and Credo, in the Coolgardie IBRA bioregion (Figure 2), occurring on yellow sandplains with associated species including *Acacia yorkrakinensis*, *Allocasuarina campestris*, *A. spinosissima*, *Calytrix cresswellii*, *Eucalyptus oldfieldii*, *Grevillea hookeriana*, *Melaleuca cordata*, and *Triodia rigidissima*.

Conservation status. Relatively widespread including in a number of nature reserves, and not considered to be under threat.

Etymology. Named in honour of Dr Barbara L. Rye (1952–), botanist at the Western Australian Herbarium, in recognition of her very significant achievements over a long career dedicated to documenting and conserving Western Australian plants. Barbara has studied and published many new Western Australian taxa in a wide range of families, including in Myrtaceae: Chamelaucieae and *Calytrix*. She is one of the all-time top ten female authors of plant names, having described, alone or in collaboration with others, 10 genera, 250 species, and 60 infraspecies taxa at the time of writing. Barbara retired in 2022 and is continuing her taxonomic research as a Research Associate at PERTH. She is much admired and appreciated by her colleagues.

Notes. *Calytrix ryeae* is a distinctive species that is widely disjunct from the other taxa in the group, all of which occur in the Western Australian wheatbelt and far south coast. It is morphologically distinctive, with short leaves with an indumentum of evenly spaced, short patent hairs of even length on all surfaces. On most specimens, the axis of the relatively few-flowered inflorescence appears determinate, with new growth occurring from the axils of the involucre bracts. This results in distinctive, short, woody stubs on lower branches, each with numerous scars where the flowers and their subtending bracts have fallen. One specimen, however, has one inflorescence where the axis has continued its apical growth, indicating that there may be some flexibility, perhaps depending on seasonal conditions.

Calytrix violacea (Lindl.) Craven, *Brunonia* 10: 119 (1987); *Lhotskya violacea* Lindl., *Sketch Veg. Swan R.* 7 (1839). *Type:* Western Australia, *s. dat.*, *J. Drummond s.n.* (*lecto, fide* L.A. Craven, *Brunonia* 10: 119 (1987): CGE *n.v.*).

Erect to sprawling *shrubs* to 0.5 m high. *Young stems* sparsely pubescent to pilose with soft, spreading, pale grey hairs 0.2–0.5 mm long (the hairs flexuose when long). *Leaves* alternate, spreading, widely scattered on long stems; *petiole* 0.4–1 mm long, glabrous or sparsely to moderately pubescent with indumentum similar to the leaves and stems; *colleters* ('stipules') 0.3–0.6 mm long, filiform to acicular, pale to dark; *lamina* linear to narrowly obovate, (4–)5–10 mm long, 0.8–1.2 mm wide, straight to slightly incurved, glabrous to sparsely villous or woolly with soft, spreading, flexuose hairs to 1 mm long; abaxial surface shallowly convex, prominently carinate; adaxial surface flat to shallowly concave with a prominent, raised rib along the midline; apex obtuse (rarely obscurely and minutely apiculate); *oil glands* not prominent, pale. *Inflorescences* condensed, comprising 5–25 flowers on an axis 10–20 mm long, terminating growth units and with the axis continuing growth after flowering (indicated by distinct, short segments of older stems bearing scars from the flowers and inflorescence-subtending floral bracts); *floral bracts* 3–7 mm long, broadly ovate to orbicular, obtuse, flattened to concavo-convex, not strongly keeled and with broad scarious ciliate margins, hirsute (rarely glabrous), the 15–45 lowermost ones without flowers and forming a ± distinct involucre subtending the inflorescence. *Peduncles* 0–0.5 mm long. *Bracteoles* shortly connate at base to form a slightly compressed, funnel-shaped cheiridium 3–3.8 mm long, each with a narrowly ovate, villous, central green portion that is not excurrent, and very broad, translucent wings (the whole bracteole almost orbicular) that are glabrous except for minute to long cilia towards the apex. *Flowers* 12–15 mm diam. *Hypanthium* not produced above the ovary, narrowly obconic, 3–4 mm long, *c.* 1 mm wide, distinctly shorter than the cheiridium, 10-ribbed, densely white-pubescent with hairs to *c.* 0.5 mm long, appressed at first becoming more spreading in fruit. *Sepals* very broadly ovate to orbicular, not emarginate, 1.8–2.5 mm long, 1.8–2.2 mm wide, moderately to densely hairy outside on the herbaceous part, glabrous on the broad, scarious margin; awn absent. *Petals* purple (darker at the base), ovate, 5.5–7 mm long, 2.8–3.5 mm wide. *Stamens plus staminodes* 55–75, 3- or 4-seriate, with the longest stamens in the outermost series and reduced stamens or staminodes in the innermost series; longest filaments 4.5–5.5 mm long, purple; largest anthers *c.* 0.25 mm long, yellow; staminodes *c.* 1 mm long. *Ovary* yellowish on the summit; ovules 2. *Style* 5–6 mm long. *Fruits* 3–3.5 mm long, densely pubescent, the narrowly obconical hypanthium *c.* 1.5 mm wide below the calyx.

Diagnostic features. Distinguished from its segregates by the following combination of characters: leaves relatively long (the lamina usually 5–10 mm long), shallowly concavo-convex (flattish), obtuse, usually with an indumentum of long, fine, flexuose hairs; inflorescences comprising 5–25 flowers, forming a contracted head with the axis growing on after flowering; floral bracts 3–7 mm long, broadly ovate to orbicular, obtuse, the 15–45 lowermost ones without flowers and forming a \pm distinct involucre subtending the inflorescence; hypanthium not exceeding the cheiridium.

Selected specimens examined. WESTERN AUSTRALIA: sandheaths N of Greenhills, Sep. 1934, *C.A. Gardner s.n.* (PERTH); Dale district, 6 Oct. 1942, *C.A. Gardner* 6468 (PERTH); K. Binnings Property, central Needling Hills, E of York, 10 Sep. 2005, *H. Green & A. Sole* KB 109 (PERTH); Site 227, Property of R. Boase, W side of Nambling South Rd, N of Cunjardine River, SE of Goomalling, 19 Sep. 2008, *M. Hislop, P. Lewis & C. Curnow* WW 227-22 (PERTH); Bobakine Nature Reserve, Jilyading Drive, Northam, at the radio tower, 22 Oct. 2000, *F. Hort* 1198 (PERTH); uncleared privately owned land on CG 10492, 1 km NW Mawson Siding, 19 km W Quairading, 8 Sep. 1977, *B.G. Muir* 510 (4) (PERTH); 8 miles SW of Beverley, 30 Aug. 1963, *K.R. Newbey* 884 (PERTH); Avon location 6539, SW side of Goldfields Rd no. 349 at junction with Rd no. 260, 24 km by road NE of York, 6 Oct. 1983, *S. Patrick* 55 (PERTH); Banksia Block, Kokeby Water Reserve, Mount Kokeby, 14 Sep. 2003, *T. Watson* 480 (PERTH).

Phenology. Flowers mainly in September and October.

Distribution and habitat. *Calytrix violacea* occurs in the western part of the Western Australian wheatbelt between approximately Goomalling, Northam, Brookton and Quairading, where it occurs in shrublands and low woodlands on white and yellow sandy soils on plains and hilltops among granite and laterite, with associated species including *Adenanthos cygnorum*, *Allocasuarina humilis*, *Banksia* spp., *Calothamnus sanguineus*, *Eucalyptus wandoo*, *Leptospermum erubescens*, *Melaleuca leptospermoides*, and *Xylomelum angustifolium*.

Conservation status. *Calytrix violacea* is widespread, occurs in a number of nature reserves, and is not considered to be under threat.

Typification. Craven (1987: 120) discussed his selection of an unnumbered Drummond specimen from Lindley's herbarium in CGE as the lectotype for *Lhotskya violacea* and indicated that sheets from MEL, NSW and W were possible isoelectotypes because they agreed well with the lectotype. However, he noted that they could not be confirmed as isoelectotypes because the CGE specimen gave no information other than the collector's name.

Images on *Global Plants* of possible type sheets that have been annotated by Craven as *Calytrix violacea* include MEL 86910 and NSW 199380, which are of the Drummond 162 collection, with the latter specimen giving a date of 1843. Two other MEL sheets (86904 and 86911) have the number 162 given in square brackets and no date recorded. We have not listed any of these specimens as possible isoelectotypes as it seems unlikely that they are from the same collection as the lectotype.

We are unable to assess the W sheet, which is not available on *Global Plants*, but there are two further images on *Global Plants* for material that was not cited by Craven (1987). Those sheets, G 00227413 and G 00227414, give the collection as *J. Drummond s.n.* and the date as 1839. The W and G sheets could possibly be isoelectotypes.

Notes. *Calytrix violacea* as circumscribed here is best distinguished from the more widespread *C. mucronulata* in having longer, flatter leaves that are obtuse and often bear a soft indumentum of long, flexuose hairs, and floral bracts that are relatively large, broadly ovate to orbicular, and obtuse. The flowers in *C. violacea* are slightly larger in all respects than those of *C. mucronulata*. In both species the inflorescences are usually compact, with the inflorescence axis continuing growth during or shortly after anthesis.

While mostly parapatric, *C. violacea* s. str. and *C. mucronulata* have been collected growing together in intermixed stands at a location near Goomalling (M. Hislop pers. comm.; see *M. Hislop, P. Lewis & C. Curnow* WW 227-22 and 227-26). They were noted at the time as being clearly different, and with no intermediates. This and the clear morphological separation evident from herbarium specimens indicate that they are clearly separable at species rank.

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References

- Abadi, S., Azouri, D., Pupko, T. & Mayrose, I. (2019). Model selection may not be a mandatory step for phylogeny reconstruction. *Nature Communications* 10: 1–11.
- Barrett, M.D., Craven L.A. & Barrett, R.L. (2009). *Calytrix gomphrenoides* (Myrtaceae), a new species from the Kimberley Region of Western Australia. *Nuytsia* 19: 1–8.
- Craven, L.A. (1987). A taxonomic revision of *Calytrix* Labill. (Myrtaceae). *Brunonia* 10: 1–138.
- Craven, L.A. (1990). Three additional species in *Calytrix* (including the reduction of *Calythropsis*), and notes on *Calytrix exstipulata* (Myrtaceae). *Australian Systematic Botany* 3: 719–725.
- Keighery, G.J. (2004). Taxonomy of the *Calytrix ecalycata* complex (Myrtaceae). *Nuytsia* 15: 261–268.
- Nge, F.J., Keighery, G.J. & Thiele, K.R. (2017). A revision of the *Calytrix acutifolia* complex (Myrtaceae: Chamelaucieae). *Nuytsia* 28: 321–337.
- Nge, F.J., Biffin, E.B., Waycott, M. & Thiele, K.R. (2021). Phylogenomics and continental biogeographic disjunctions: insight from the Australian starflowers (*Calytrix*). *American Journal of Botany* 109: 291–308.
- Rye, B.L. (1979). Chromosome number variation in the Myrtaceae and its taxonomic implications. *Australian Journal of Botany* 27: 547–573.
- Rye, B.L. (2013). An update to the taxonomy of some Western Australian genera of Myrtaceae tribe Chamelaucieae. 1. *Calytrix*. *Nuytsia* 23: 483–501.
- Rye, B.L. (2020). *Calytrix insperata* (Myrtaceae: Chamelaucieae), a new Western Australian species opportunistically discovered on vacation. *Nuytsia* 23: 19–22.
- Smith, T., Mauck, W.M., Benz, B.W. & Andersen, M.J. (2020). Uneven Missing Data Skew Phylogenomic Relationships within the Lories and Lorikeets. *Genome Biology and Evolution* 12: 1131–1147.
- Stamatakis, A. (2014). RAxML version 8: a tool for phylogenetic analysis and post-analysis of large phylogenies. *Bioinformatics* 30: 1312–1313.
- Western Australian Herbarium (1998–). *Florabase—the Western Australian flora*. Department of Biodiversity, Conservation and Attractions. <https://florabase.dpaw.wa.gov.au/> [accessed 5 April 2022].

**Description of a new south-western Australian
plant group, *Hypocalymma* sect. *Grandiflora*
(Myrtaceae: Chamelaucieae: Astarteinae)**

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Abstract

Rye, B.L., Keighery, G.J. & Barrett, M.D. Description of a new south-western Australian plant group, *Hypocalymma* sect. *Grandiflora* (Myrtaceae: Chamelaucieae: Astarteinae). *Nuytsia* 33: 233–249 (2022). A new section of *Hypocalymma* (Endl.) Endl., *H. sect. Grandiflora* Rye, Keighery & M.D.Barrett, is described. Like sect. *Hypocalymma*, the new section has seeds with a pitted testa, but it differs in having solitary axillary flowers with large petals greatly exceeding the length of the stamens. Its type species is *H. puniceum* C.A.Gardner and three of its five species are new: *H. inopinatum* Rye, Keighery & M.D.Barrett, *H. magnificum* Rye, Keighery & M.D.Barrett, and *H. polyandrum* Rye, Keighery & M.D.Barrett. Keys are given to the four sections of *Hypocalymma* and to the species of sect. *Grandiflora*. Four species have conservation priority.

Introduction

Hypocalymma (Endl.) Endl. is a south-western Australian genus of Myrtaceae tribe Chamelaucieae DC., currently with 28 published species and ten phrase-named species or subspecies listed on *Florabase* (Western Australian Herbarium 1998–). The high degree of morphological diversity within the genus, with obvious discontinuities between four main species groups, makes the development of an infrageneric classification of higher priority in *Hypocalymma* than in some other moderately large genera, such as *Astartea* DC. and *Micromyrtus* Benth.

In 2013, the previously named sections of *Hypocalymma* were reviewed (Rye *et al.* 2013) and it was concluded that only two of them should be recognised, sect. *Hypocalymma* with pitted seeds and sect. *Cardiomyrtus* Schauer with smooth or colliculate seeds. However, the morphological and molecular data suggested that two additional species groups needed to be recognised at some level, one with pitted seeds and the other with smooth seeds. The latter section was described, as *H. sect. Verticilla* Rye, and the other smooth-seeded section was fully revised.

The current paper presents additional molecular data and a full description of the new species group with pitted seeds, the '*Hypocalymma puniceum* group' of Rye *et al.* (2013), as *H. sect. Grandiflora*

Rye, Keighery & M.D.Barrett. Section *Grandiflora* comprises five species, of which three are new and four have conservation priority.

Taxonomic history

For a history of *Hypocalymma* and its previously published sectional names see Rye *et al.* (2013). At the time the first sections were being established for the genus, by Schauer (1844), Turczaninow (1862) and Bentham (1867), all of the species treated here were unknown. The earliest collection of the plant group revised here was made by Charles Gardner in February 1923 and later in the same year used as the type of *H. puniceum* C.A.Gardner (Gardner 1923). Gardner noted that *H. puniceum* differed from the two species he indicated as being its closest relatives in its larger, solitary flowers and in having the style inserted in a depression. A second species was discovered in 1948 and recognised by the unpublished name *H. melaleucoides* C.A.Gardner ms.

Eventually, Strid and Keighery (2002) described Gardner's second species. They noted that *H. puniceum* and *H. melaleucoides* C.A.Gardner ex Strid & Keighery had stamens that were much shorter than the petals, and placed the two taxa together in their systematic ordering of the species. Three additional members of this species group were allocated informal names between 1998 and 2007.

Recent molecular studies of *Hypocalymma* species using the nuclear ribosomal DNA external transcribed spacer (ETS) region and several chloroplast regions (Wilson & Heslewood 2011; Rye *et al.* 2013), included a single species of the new section, *H. puniceum*. That species was very strongly supported (100% jk) as sister to a robust clade of four species of sect. *Hypocalymma*.

Methods

Taxonomic methods

Methods for obtaining measurements are as given in Rye *et al.* (2013). Distributions were plotted from data obtained from *Florabase* (Western Australian Herbarium 1998–), on maps showing the version 6.1 Interim Biogeographic Regionalisation for Australia (IBRA) regions (Department of the Environment, Water, Heritage and the Arts 2008).

DNA extraction and sequencing

A total of 20 specimens, representing each of the sections of *Hypocalymma* and outgroups from the related genera *Cyathostemon* Turcz. and *Seorsus* Rye & Trudgen of subtribe Astarteinae Rye & Peter G. Wilson, were used to generate ETS sequences for an expanded phylogeny of *Hypocalymma*. Voucher specimens for the sequences, and Genbank accession numbers are listed in Table 1.

Approximately 500 mg of leaf tissue was ground in liquid nitrogen, then again in Carlson extraction buffer (Csaikl *et al.* 1998), and genomic DNA extracted using a modified CTAB extraction protocol (Doyle & Dickson 1987): ground tissue was incubated for 15 mins at 65°C, proteins removed using a suspension of 24:1 chloroform : isoamyl alcohol mix shaken for 30 mins, followed by precipitation with an equal volume of isopropanol for 20–30 mins at -20°C, and the pellet washed with 70% ethanol. Between each step the supernatant or DNA pellet was recovered by spinning at 13,000 rpm for 10 mins. After drying, the DNA pellet was suspended in TE buffer.

Table 1. Voucher specimens for molecular sequencing.

| Taxon | Voucher | PERTH barcode | Genbank accession number for ETS sequence |
|--|--|---------------|---|
| <i>Cyathostemon gracilis</i> Trudgen & Rye | <i>M. Bennett</i> 1212 | 08063974 | OM650693 |
| <i>C. verrucosus</i> Trudgen & Rye | <i>S. Reiffer</i> SRE 305 | 08284822 | OM650694 |
| <i>Hypocalymma angustifolium</i> (Endl.) Schauer | <i>C. Tauss</i> 6834 | 09376895 | OM650695 |
| <i>H. elongatum</i> (Strid & Keighery) Rye | <i>S. Hitchcock</i> & <i>R. Haycock</i> M 165 | 08674396 | OM650696 |
| <i>H. ericifolium</i> Benth. | <i>A. Matei</i> TB 108 | 08378193 | OM650697 |
| <i>H. hirsutum</i> Strid & Keighery | <i>G. Byrne</i> 3621 | 08291578 | OM650698 |
| <i>H. inopinatum</i> Rye, Keighery & M.D.Barrett | <i>S. Donaldson</i> , <i>G.T. Chandler</i> & <i>A. Munro</i> SD 2225 | 06375405 | OM650699 |
| <i>H. inopinatum</i> Rye, Keighery & M.D.Barrett | <i>B.L. Rye</i> 290156 | 08702942 | OM650700 |
| <i>H. jessicae</i> Strid & Keighery | <i>C. Tauss</i> 6200 | 08388830 | OM650701 |
| <i>H. longifolium</i> F.Muell. | <i>A.D. Crawford</i> ADC 2067 | 08271127 | OM650702 |
| <i>H. magnificum</i> Rye, Keighery & M.D.Barrett | <i>B.L. Rye</i> 290155 | 08702969 | OM650703 |
| <i>H. minus</i> (Strid & Keighery) Keighery | <i>M. Sowry</i> 109 | 07838786 | OM650704 |
| <i>H. polyandrum</i> Rye, Keighery & M.D.Barrett | <i>R. Davis, A.J. Perkins</i> & <i>B.L. Rye</i> DPR 12 | 08702950 | OM650706 |
| <i>H. puniceum</i> C.A.Gardner | <i>R. Davis, A.J. Perkins</i> & <i>B.L. Rye</i> DPR 5 | 08702934 | OM650705 |
| <i>H. robustum</i> (Endl.) Lindl. | <i>D.A. Mickle</i> & <i>M.L. Swinburn</i> 273 | 08123306 | OM650707 |
| <i>H. suave</i> Lindl. | <i>C. Tauss</i> 6848 | 09376879 | OM650708 |
| <i>H. sylvestre</i> Strid & Keighery | <i>M. Swinburn</i> 07 | 08439206 | OM650709 |
| <i>H. verticillare</i> Rye | <i>B.L. Rye</i> & <i>E.D. Middleton</i> BLR 250506 | 07131259 | OM650710 |
| <i>Seorsus clavifolius</i> (C.A.Gardner) Rye & Trudgen | <i>B.L. Rye</i> & <i>M.E. Trudgen</i> BLR 250109 | 07692404 | OM650711 |
| <i>S. clavifolius</i> (C.A.Gardner) Rye & Trudgen | <i>B.L. Rye</i> & <i>M.E. Trudgen</i> BLR 250119 | 07692382 | OM650712 |

PCR amplifications were performed in 20 μ L volumes, and consisted of a final concentration of 67 mM Tris-HCl (pH 8.8 at 25°C), 16.6 mM $(\text{NH}_4)_2\text{SO}_4$, 0.45% Triton X-100, 0.2 mg/mL gelatin, 0.2 mM of each dNTP (all diluted 1:4 in 5 \times polymerisation buffer, Fischer Biotec, Subiaco, Australia), 2 mM MgCl_2 , 0.12% v/v DMSO, 0.06% v/v BSA, and 0.2 U Taq DNA polymerase (Fischer Biotec, Subiaco, Australia), 0.5 μ M final concentration of each primer per reaction and *c.* 10–500 mg of template DNA. The ETS region was amplified using the primers ETS-18S-R (GAGCCATTCGCAGTTTCACAG, Wright *et al.* 2001) and ETS-Kunz-F (CGTGTCTGGTGCACCGAA, de Lange *et al.* 2010). The PCR

was performed on either an Applied Biosystems® Veriti® thermocycler, or GeneAmp® PCR System 9700, and used the following thermocycler profile: 95°C for 90 secs, 40× (95°C for 30 secs, 55°C for 1 min, 72°C for 90 secs), and a final extension of 72°C for 7 mins.

PCR products were verified and roughly quantified on a 2% agarose gel before removal of excess oligos by digest using 1 µL ExoSAP-IT® (Affymetrix USB) per 10 µL PCR product, then placed on a thermocycler at 37°C for 20 mins, 80°C for 15 mins, and finally held at 4°C.

Cycle sequence reactions were performed in 10 µL reaction volume, for both forward and reverse DNA strands, using BigDye® Terminator v. 3.1 chemistry (Applied Biosystems) with the same primers as for PCR, using the following PCR protocol: 96°C for 1 min, 25× (96°C for 10 secs, 50°C for 5 secs, 60°C for 4 mins). Excess dye was removed from cycle sequence reactions by precipitation in 80 µL of a 130:29:6 mix of 100% ethanol : H₂O : 3M sodium acetate mix held at room temperature for 10 mins, before centrifugation at 2500g for 45 mins, followed by washing the pellet in 70% ethanol. Fragment separation was carried out on an Applied Biosystems® 3500 Genetic Analyzer.

Chromatograms of contigs were first scored automatically then corrected manually and combined using CodonCode Aligner v. 3.5.7 (CodonCode Corporation, Dedham, MA, USA). Sequences were aligned using the MAAFT algorithm in Geneious® v. 6.1.7 (<https://www.geneious.com/>; Kearse *et al.* 2012). Phylogenetic trees were reconstructed using maximum likelihood (ML) in RAxML v. 7.8.7 (Stamatakis 2006), using the GTR GAMMA substitution model option, 100 rapid bootstrap replicates, and no partitioning of the data. The substitution mode was chosen using MODELTEST (Posada & Crandell 1998).

Distinguishing features of section *Grandiflora*

Section *Grandiflora* differs from sections *Cardiomyrtus* and *Verticilla* in leaf and seed characters (see key below). It matches sect. *Hypocalymma* in having pitted seeds but differs in having only one viable flower per axil, and longer petals which are two to four times longer than the stamens (Figure 1). In sect. *Hypocalymma* the petals vary from about as long as the stamens to not much more than half their length. The dark veining of the petals in sect. *Grandiflora* (see Figure 1A) is a character that is absent or less obvious in most species belonging to other sections.

All members of sect. *Grandiflora* have horizontal ovules and seeds, whereas all members of sect. *Hypocalymma* have erect seeds except for *H. longifolium* F.Muell. *Hypocalymma longifolium* also differs from other members of the typical section in its more numerous ovules and more compressed fruit shape, but appears typical in all other characters. Molecular data (Figure 2) confirm that *H. longifolium* is correctly placed in sect. *Hypocalymma*.

Cultivation and hybridisation

The two rarest species of *Hypocalymma* sect. *Grandiflora*, which were known as *H. sp.* Lake King (R.W. Purdie 3936) and *H. sp.* Cascade (R. Bruhn 20/896 CAS), have been in cultivation for some time at Kings Park. Both ‘offer attractive grey-green foliage, large dark pink flowers for six months of the year and are excellent container plants’ (Anon. 2012: 20). *Hypocalymma puniceum* has also been in cultivation for some time (Elliot & Jones 1990). Attempts to produce hybrid seeds by cross-pollination between *H. angustifolium* (Endl.) Schauer *s. lat.* and members of the new section have



Figure 1. A – *Hypocalymma magnificum* flowering stem with ovate leaves, a solitary flower at one node and a solitary bud at the node above; B – *H. polyandrum* flowering stem with a solitary flower and thick leaves with prominent glands. Images by Rob Davis from B.L. Rye 290155 (A) and R. Davis, A.J. Perkins & B.L. Rye DPR 12 (B).

failed (D. Growns pers. comm.) although *H. angustifolium* s. lat. can produce hybrids with a range of species belonging to its own group, sect. *Hypocalymma*.

Molecular sequencing

The RAxML phylogenetic tree based on an analysis of ETS sequences of 16 samples of *Hypocalymma*, including three undescribed taxa allocated phrase names, and four outgroups is shown in Figure 2. When rooted with *Cyathostemon* and *Seorsus*, the genus *Hypocalymma* is supported as monophyletic (82% BS). The two sections represented here by more than one sample (sect. *Hypocalymma* and the new sect. *Grandiflora*) are both monophyletic (97% and 89% BS respectively), to the limit of our species sampling. Within sect. *Grandiflora*, the subject of this paper, the phylogeny suggests two strongly supported subclades in the section. *Hypocalymma puniceum* s. str. and *H. puniceum* subsp. Cadoux (H. Demarz 10533) are strongly supported (100% BS) as sister taxa, with the latter herein described as *H. polyandrum* Rye, Keighery & M.D. Barrett. The unnamed taxa *H. sp.* Lake King (R.W. Purdie 3936) and *H. sp.* Cascade (R. Bruhn 20/896 CAS), are also strongly supported (100% BS) as sister taxa and are described here as *H. inopinatum* Rye, Keighery & M.D. Barrett and *H. magnificum* Rye, Keighery & M.D. Barrett, respectively. *Hypocalymma melaleucoides* is the sole species of sect. *Grandifolia* not represented in the molecular tree.

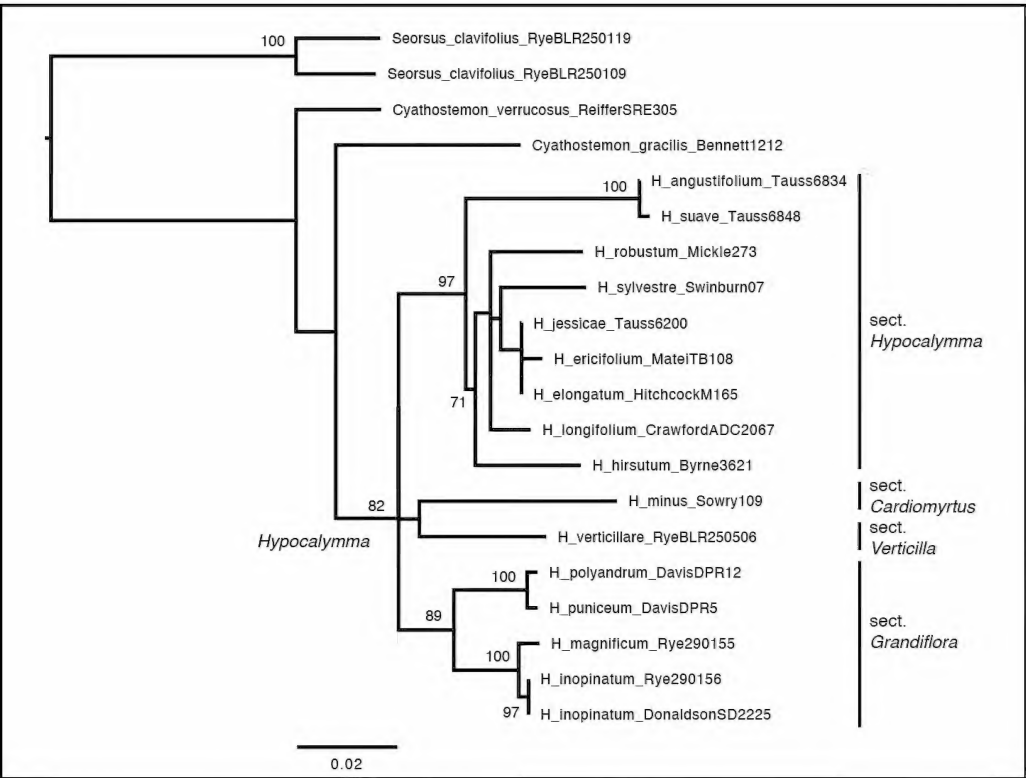


Figure 2. RAxML phylogenetic tree based on an analysis of ETS sequences of 16 samples of *Hypocalymma* and four outgroups. The tree is rooted with *Cyathostemon* and *Seorsus*. Bootstrap support values (BS) more than 70% are indicated above branches. Note that the genus *Hypocalymma* is supported as monophyletic, and the two sections represented by more than one sample (sect. *Hypocalymma* and the new sect. *Grandiflora*) are monophyletic.

Descriptions and keys

Key to sections of *Hypocalymma*

1. Leaves with margins recurved to revolute, discolorous with upper surface darker than undersurface. Stamens 10–50, connate at base or free. Seeds smooth or minutely colliculate, 0.8–1.7 mm long. Occurring south of Perth, restricted to the most humid parts of the South West Botanical Province
2. Young stems 3-angled, glabrous, each angle with a rounded ridge that is directly opposite the petiole above. Leaves in whorls of three, with oil glands in 2 or 3 main irregular rows. Androecium of 15–26 filaments, united for at least half of their length sect. **Verticilla**
- 2: Young stems either hairy or slightly to markedly 4-winged, the 4 angles or wings alternating with the leaves above and below. Leaves opposite, dotted with numerous minute oil glands. Androecium of 10–50 filaments, united only at base or free sect. **Cardiomyrtus**
- 1: Leaves with margins usually level or gently incurved to inrolled, concolorous or with upper surface paler than undersurface (if with upper surface darker then occurring north of Perth). Stamens 12–200, connate at base or for up to half their

length. Seeds shallowly to deeply reticulate-pitted, 1.3–2.5 mm long. Widespread in the South West Botanical Province

3. Flowers paired in all or many of the axils. Petals 2.5–5.5 mm long, yellow, pink or white, persistent or shed in fruit. Longest stamens about as long as or exceeding the petalssect. **Hypocalymma**
- 3: Flowers solitary in the axils (rarely also with an aborted flower present). Petals 6–14 mm long, mauve to deep pink, shed in fruit. Stamens all much shorter than the petals sect. **Grandiflora**

Hypocalymma sect. **Grandiflora** Rye, Keighery & M.D.Barrett, *sect. nov.*

Type: Hypocalymma puniceum C.A.Gardner.

Shrubs up to 1.5 m high, single-stemmed or multi-branched at base or sometimes recorded as lignotuberous, glabrous; flowering branchlets few-flowered (often just 1-flowered), the flowers solitary at each node (rarely also with an aborted flower present). *Leaves* opposite and decussate. *Petioles* absent or short. *Leaf blades* with incurved or level margins, concolorous or with upper surface slightly paler. *Peduncles* 0.4–2.5 mm long, 1-flowered. *Bracteoles* with incurved margins, entire. *Pedicels* short or absent. *Hypanthium* shortly cup-shaped or more obconic, with rather closely packed oil glands, which often appear somewhat sunken. *Sepals* 1–4 mm long, broad-based, broadly obtuse, entire, with an herbaceous part dotted with oil glands and a broad or narrow petaline border. *Petals* 6–14 mm long, mauve to deep pink, usually bright pink with multiple veins visible as darker markings, narrowed or shortly clawed at the base, entire, shed in fruit. *Staminodes* rare or absent. *Stamens* 35–130, in 2 or 3 series, united shortly at base into a continuous ring. *Longest filaments* filiform, much shorter than the petals, pink. *Anthers* yellow, with cells curved around a central connective gland, which is visible on the ventral surface. *Ovary* 2–4-locular, *c.* 1/2-inferior or largely inferior, the superior part with ridges corresponding with the junctions of the loculi; ovules 3–11 per loculus, horizontal. *Style* 2.5–5.5 mm long, pink, with base inset into a depression in the summit of the ovary; stigma very small. *Fruits* thick-walled; hypanthium becoming flattened and rugose-wrinkled as valves open. *Seeds* horizontal, crustaceous, irregularly ovoid or broadly so to almost reniform, 1.5–2.5 mm long; body unfacetted or somewhat facetted, shallowly to moderately deeply reticulate-pitted, pale to dark brown; inner protrusion (elaiosome) large, forming a whitish zone on inner surface of seed distal to the hilum, usually also extending laterally along each side of hilum but not or scarcely encircling it at the base; hilum towards base of inner surface. *Chaff pieces* strongly compressed and \pm reniform in outline or (if late-aborted) less compressed and of a more irregular shape, shorter than seeds, brown with a white inner protrusion, crustaceous.

Diagnostic characters. *Leaves* concolorous or with upper surface paler. *Sepals* 1–4 mm long. *Petals* 6–14 mm long, bright pink, shed in fruit. *Stamens* 35–130, in 2 or 3 series, united into a continuous ring at the base, much shorter than the petals, with anther cells curved around a central ventral connective gland. *Ovary* 2–4-locular, *c.* 1/2-inferior or largely inferior; ovules 3–11 per loculus. *Style* 2.5–5.5 mm long; base inset. *Seeds* reticulate-pitted, 1.5–2.5 mm long, pale to dark brown.

Size, distribution and phenology. Section *Grandiflora* contains five species and extends from Ballidu in the central wheatbelt south-east to Fitzgerald River National Park and Young River on the south coast of Western Australia.

Figure 3 shows the distributions of all four sections of *Hypocalymma*. As in sect. *Cardiomyrtus*, species belonging to the new section seem to have more extensive flowering periods than are found in most

members of sect. *Hypocalymma*. This may partly reflect the occurrence of both *Cardiomyrtus* (Figure 3A) and *Grandiflora* (Figure 3A) primarily towards the south coast where summer conditions tend to be less extreme and flowering periods are less likely to be restricted to the spring months, whereas sect. *Hypocalymma* (Figure 3B) has more than half of its species in the northern sandplains. The single known locality of sect. *Verticilla* (Figure 3B) is also near the south coast but the section is too poorly known for its phenology to be clear.

Etymology. From the Latin *grandi-* (large) and *-florus* (flowered), as these species have large flowers with petals much longer than the stamens.

Notes. The five species belonging to sect. *Grandiflora* never co-occur because there is no overlap in their geographic distributions (see Figure 4). Although this plant group never has more than one obvious flower per peduncle, *H. puniceum* sometimes has an abortive flower as well as the viable flower (see notes under that taxon).

Key to species of *Hypocalymma* sect. *Grandiflora*

1. Leaves linear in outline, thick. Ovary 2-locular in all or most flowers
 2. Young stems smooth to moderately rugose. Mature leaves with oil glands usually not very prominent; abaxial surface with 15–27 moderately closely packed oil glands in the 2 rows closest to (i.e. on either side of) the midvein. Stamens 35–55.
(Ballidu–Lake Grace area) ***H. puniceum***
 - 2: Young stems moderately to very rugose. Mature leaves with oil glands usually very prominent; abaxial surface with 9–14 widely spaced oil glands in the 2 rows closest to (i.e. on either side of) the midvein. Stamens 75–130. (Kirwan–Manmanning) ***H. polyandrum***
- 1: Leaves narrowly ovate to obovate or elliptic. Ovary 3(4)-locular in all or most flowers
 3. Leaves sessile, ovate, 4–7 mm wide. Petals c. 14 mm long. Ovules 7–11 per loculus (Young River area) ***H. magnificum***
 - 3: Leaves with a petiole 0.5–0.9 mm long; blade narrowly ovate or obovate to almost elliptic, 1.5–3 mm wide. Petals 6–10 mm long. Ovules 3–5 per loculus
 4. Young stems smooth. Leaf margins gently incurved. Petals at least 8–10 mm long (Lake King area) ***H. inopinatum***
 - 4: Young stems minutely tuberculate. Leaf margins strongly incurved. Petals 6–8 mm long (Fitzgerald River NP) ***H. melaleucoides***

Hypocalymma inopinatum Rye, Keighery & M.D.Barrett, *sp. nov.*

Type: east from Lake King, Western Australia [precise locality withheld for conservation reasons], 2 November 1990, R.W. Purdie 3936 (*holo:* PERTH 06073239; *iso:* CANB CBG 9011639).

Hypocalymma sp. Lake King (R.W. Purdie 3936), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 8 March 2022].

Shrub up to 1 m tall, with slender flowering stems. *Young stems* somewhat ridged below each petiole at first, becoming smooth and \pm terete. *Leaves* mostly antrorse to very widely antrorse. *Petioles* well defined, 0.5–0.8 mm long. *Leaf blades* obovate to elliptic, 4.5–7 mm long, 2–3 mm wide, obtuse, with moderately incurved margins, entire, \pm concolorous or with abaxial surface darker than adaxial surface; abaxial surface convex, with 3 or 4 main rows of usually 8–13 oil glands; adaxial surface concave,

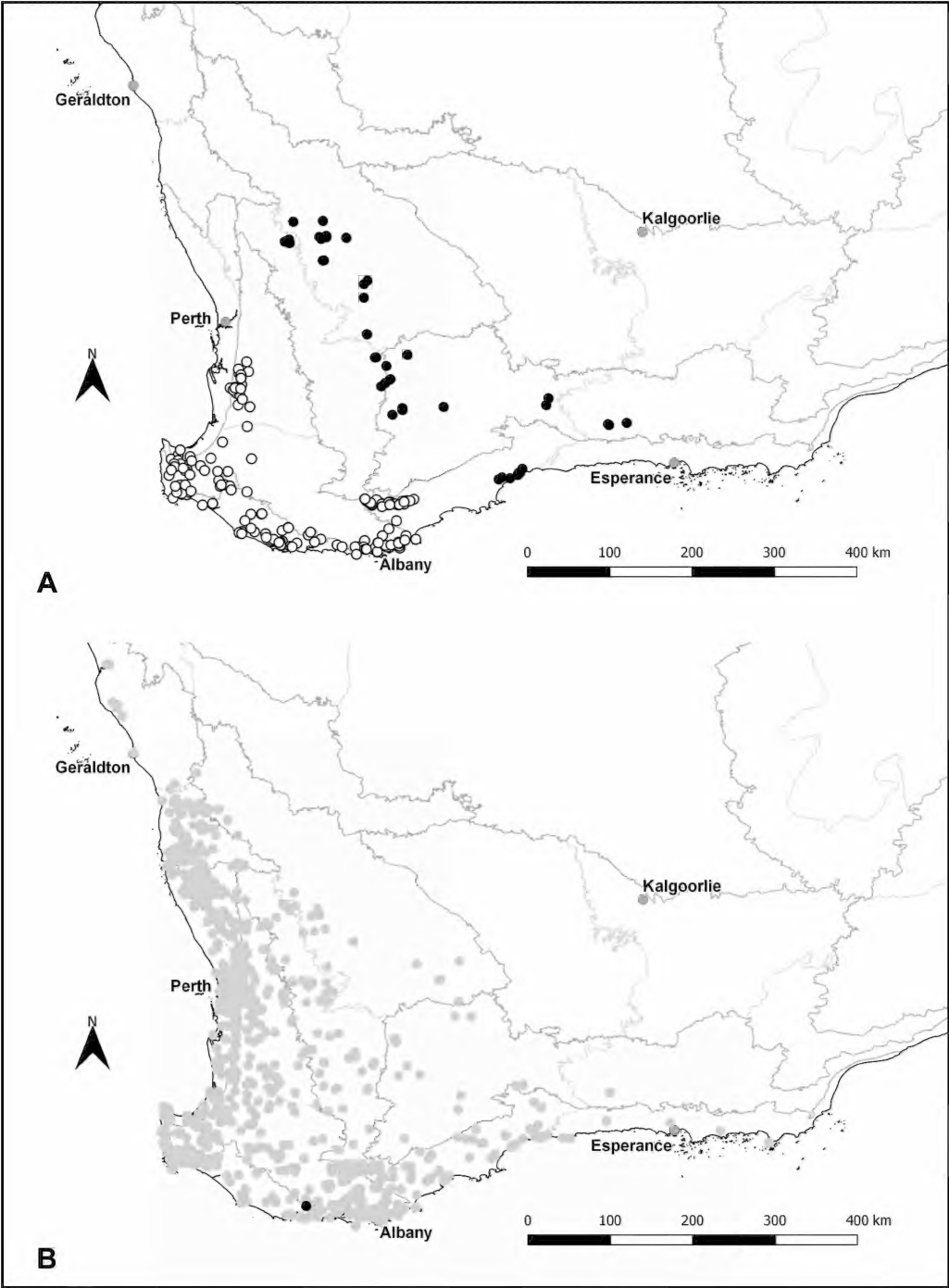


Figure 3. Distribution maps for the sections of *Hypocalymma*. A – *H. sect. Cardiomyrtus* (○) and *H. sect. Grandiflora* (●); B – *H. sect. Hypocalymma* (●) and *sect. Verticilla* (●).

with oil glands usually less conspicuous; apical point absent. *Peduncles* borne at 1–3 consecutive nodes, often with only one per node, 1-flowered, 1.5–2.5 mm long. *Bracteoles* herbaceous, often persistent in flower, 3–3.5 mm long. *Pedicels* 1–2 mm long. *Flowers* 15–20 mm diam. *Hypanthium* 1.3–1.7 mm long, 3–3.5 mm diam., dotted with inconspicuous oil glands; free part 0.6–1 mm long. *Sepals* depressed ovate, 2–2.5 mm long, 2.5–3 mm wide, herbaceous, with an extremely narrow hyaline margin. *Petals* 8–10 mm or more long. *Stamens* commonly 55–65. *Longest filaments* 3–4 mm long, united at base for *c.* 0.5 mm. *Anthers* 0.6–0.7 mm long. *Ovary* 3- or 4-locular, more than half inferior; summit moderately to prominently ridged; ovules 4 or 5 per loculus. *Style* *c.* 4 mm long; stigma 0.15–0.2 mm diam. *Fruits* *c.* half-inferior, depressed-globular, 3–3.5 mm long, *c.* 5 mm diam. *Seeds* 1.6–2.1 mm long, 0.7–1 mm wide, 0.8–1.3 mm thick, medium brown to dark red-brown; inner protrusion 1.4–1.5 mm long, 0.5–0.6 mm wide; hilum located within broad end of seed, 0.3–0.4 mm diam. *Chaff pieces* 1.2–1.4 mm long.

Diagnostic characters. *Leaves* shortly petiolate; blade obovate to elliptic. *Petals* 8–10 mm or more long. *Stamens* *c.* 60. *Longest filaments* 3–4 mm long. *Ovary* 3- or 4-locular; ovules 4 or 5 per loculus. *Seeds* 1.6–2.1 mm long, medium brown to dark red-brown.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 17 Sep. 1999, *S. Donaldson* 2225, *G.T. Chandler* & *A. Munro* (PERTH, CANB); cultivated in gardens surrounding the Western Australian Herbarium, Kensington, 15 Aug. 2014, *B.L. Rye* 290156 (PERTH).

Distribution and habitat. Occurs at two localities east of Lake King in the Mallee bioregion (Figure 4), one in shallow sandy soil on the crest of a low hill with *Melaleuca* spp. open shrubland and scattered emergent eucalypts, the other in white sand on laterite on a moderate slope with mallee eucalypts.

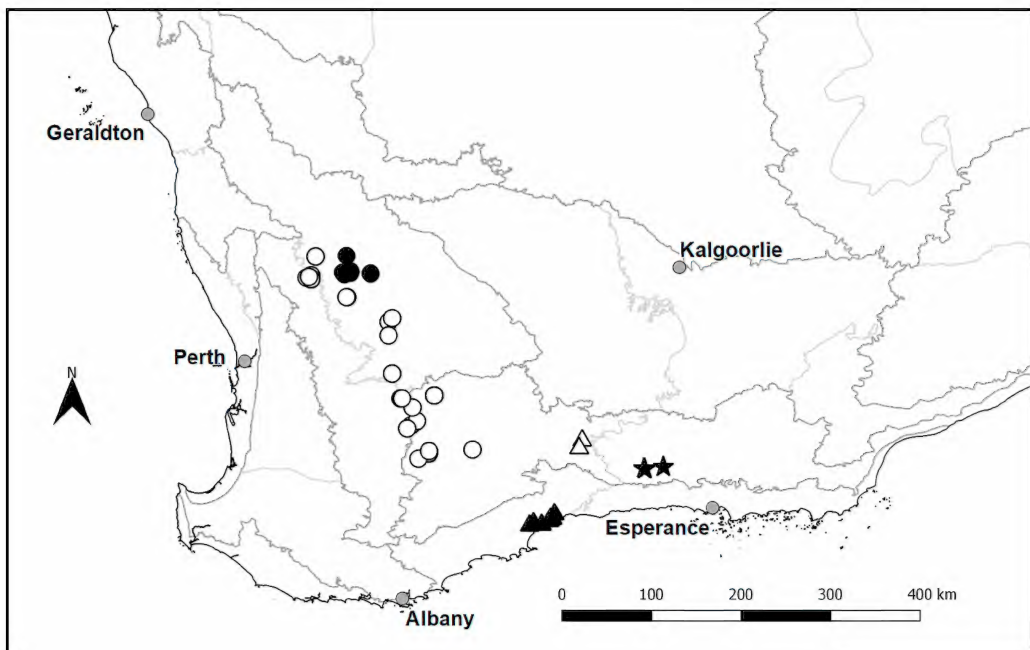


Figure 4. Distribution map for members of *Hypocalymma* sect. *Grandiflora*: *H. inopinatum* (△), *H. magnificum* (★), *H. melaleucoides* (▲), *H. polyandrum* (●) and *H. puniceum* (○).

Phenology. Flowers have been recorded from September to November and mature fruits in November.

Conservation status. Listed as Priority Two under the Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *H. sp.* Lake King (R.W. Purdie 3936). Described as uncommon at one locality and frequent at the other locality.

Etymology. From the Latin *inopinatus* (unexpected) as this very attractive species was first encountered by one of the authors (GJK) amongst the herbarium specimens and cultivated plants at Canberra rather than in its home state.

Vernacular name. Lake King Myrtle.

Affinities. Somewhat intermediate in morphology between *H. melaleucoides* and *H. magnificum* but differing in the characters given in the key and noted under those two taxa.

Notes. The habit of *H. inopinatum* needs further study as it is not yet known whether the species is lignotuberous and how well it regenerates after fires.

Most specimens have a 3-locular ovary on all flowers that have been examined, but on R.D. Purdie 3936 the ovary is equally 4-locular on the single flower present, and its single dehiscent fruit is 4-locular with one loculus small and abortive. This suggests that the flowers of this specimen are predominantly 4-locular, although one less mature fruit was found to be 3-locular with two functional loculi and an abortive loculus.

Hypocalymma magnificum Rye, Keighery & M.D.Barrett, *sp. nov.*

Type: Cascade Reserve, Western Australia [precise locality withheld for conservation reasons], 26 August 1996, R. Bruhn 20/896 CAS (*holo:* PERTH 04454154; *iso:* AD 99715263, CANB, K, MEL, ?NSW).

Hypocalymma sp. Cascade (R. Bruhn 20/896 CAS), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 387 (2000); Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 8 March 2022].

Shrub 0.4–1 m tall, one specimen recorded as 0.3–0.4 m wide, single-stemmed at the base. *Young stems* ± terete, smooth. *Leaves* mostly widely spreading, sessile, ovate, 8–11 mm long, 4–7 mm wide, acute or obtuse, with moderately incurved margins, entire, ± concolorous, with midvein not protruding and scarcely visible; abaxial surface convex, dotted with numerous minute oil glands; adaxial surface concave; apical point absent. *Peduncles* usually borne at 1 or 2 consecutive nodes, often with only one per node, 1-flowered, 1–1.5 mm long. *Bracteoles* usually shed in bud, 4–5.5 mm long. *Pedicels* 0.7–1 mm long. *Flowers* 20–30 mm diam. *Hypanthium* 2–3 mm long, 3.5–5 mm diam.; free part 0.8–1.2 mm long. *Sepals* depressed ovate, 3–4 mm long, 4–5 mm wide, green with a broad pinkish margin or the margin pink with a narrow white extremity. *Petals* 11–15 mm long. *Stamens* 65–110. *Longest filaments* 3–4 mm long, united for c. 0.4 mm at base. *Anthers* 0.5–0.6 mm long. *Ovary* 3(4)-locular, largely inferior (only the ridges superior); ovules 7–11 per loculus. *Style* 3.7–4.3 mm long; stigma 0.15–0.2 mm diam. *Fruits* c. 1/2 inferior, depressed-globular, 3–4 mm long, 4–5 mm diam. *Seeds* 1.8–2.1 mm long, 1–1.3 mm wide, 1.1–1.3 mm thick, medium brown; inner protrusion 1.25–1.4 mm long, 0.6–0.8 mm wide; hilum located within the broad end of the seed, c. 0.4 mm diam. *Chaff pieces* 1.2–1.5 mm long. (Figure 1A)

Diagnostic characters. Leaves sessile, broadly ovate to cordate or ovate. Petals 11–15 mm long. Stamens 65–110. Longest filaments 3–4 mm long. Ovary 3(4)-locular; ovules 7–11 per loculus. Fruits c. 1/2 inferior, circular from top view. Seeds 1.8–2.1 mm long, medium brown.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 31 Aug. 2010, E.D. Adams, J. Ford & C.D. Turley EA 636 (PERTH); 10 Nov. 2007, M. Crowhurst 196 (KPBG, PERTH); Esperance Wildflower Show, 8 Sep. 2014, J. Holmes JLW 1412/05 (PERTH); cultivated in gardens surrounding the Western Australian Herbarium, Kensington, 30 Aug. 2013, B.L. Rye 290155 (NSW, PERTH).

Distribution and habitat. Occurs in the upper Young River area of the Mallee bioregion (Figure 4), where it is recorded in shallow sandy soil over granite adjacent to a rock sheet, with mallee *Eucalyptus* species.

Phenology. Flowers recorded from August to November and mature fruits in late August.

Conservation status. Listed as Threatened (Endangered) in Western Australia (Smith & Jones 2018) and Australia (Department of the Environment 2022) as *H. sp.* Cascade (R. Bruhn 20/896 CAS). Known from only one confirmed locality, where it was reported to be frequent in 2010 (E.D. Adams, J. Ford & C.D. Turley EA 636) with a note that it appeared to be a ‘disturbance opportunist’. The species is well established in cultivation.

Etymology. From the Latin *magnificus* (splendid), as this species has the largest, most spectacular flowers in the genus.

Vernacular name. Superb Myrtle.

Affinities. Distinguished from *H. inopinatum*, which seems to show the greatest similarity, by its broader, sessile leaves and larger flowers with more numerous stamens and ovules.

Notes. *Hypocalymma magnificum* lacks a lignotuber and is readily killed by fires and mechanical clearance; however, it reproduces readily by seed. The holotype has been parasitised by *Cassytha*.

One flower examined from each of the field-collected specimens of *H. magnificum* had a 4-locular ovary, suggesting that this character may be more frequent in this species than in other members of the genus; however all of the fruits examined were 3-locular.

The cultivated specimen B.L. Rye 290155, derived from a cutting taken in Kings Park, had developed a very stout basal stem, over 20 mm across, about two years after it was planted. Although its petals were up to 15 mm long, they had an incurved margin, restricting the flower diameter to 25 mm. Its stamen filaments were deep pink or maroon.

Hypocalymma melaleucoides C.A.Gardner ex Strid & Keighery, *Nord. J. Bot.* 22: 564 (2002). *Type:* Fitzgerald River National Park, Western Australia [precise locality withheld for conservation reasons], 6 October 1993, C.A. Robinson 1187 (*holo:* PERTH 03555801; *iso:* CANB 599027, NSW 441695, PERTH 03369455).

Hypocalymma sp. Marshes Beach (C.R. Hart 11), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 8 March 2022].

Shrub 0.3–0.5 m high, commonly 0.55–0.8 m wide. *Young stems* \pm terete, densely and minutely tuberculate. *Leaves* widely spreading or antrorse. *Petioles* well defined, 0.5–0.9 mm long. *Leaf blades* narrowly ovate to elliptic, 4–6 mm long, 1.5–2 mm wide, entire, margins strongly incurved; abaxial surface darker than adaxial surface, convex, with midvein not protruding and scarcely visible, dotted with numerous minute oil glands; adaxial surface concave, with oil glands similar to those on abaxial surface but more obvious because of the paler background colour; apical point absent. *Peduncles* borne at 1–3 consecutive nodes, often with only one per node, 1-flowered, 0.5–2 mm long. *Bracteoles* caducous or shed in flower, 3–4 mm long. *Pedicels* *c.* 1 mm long. *Flowers* 13–17 mm diam. *Hypanthium* 1.5–2 mm long, *c.* 3 mm diam.; free part 0.4–0.6 mm long. *Sepals* depressed ovate, 1–2 mm long, 2.3–2.7 mm wide, green with a broad, whitish to deep pink border. *Petals* 6–8 mm long. *Stamens* 35–55. *Longest filaments* 3–4 mm long, united for *c.* 0.4 mm at base. *Anthers* 0.4–0.45 mm long. *Ovary* 3-locular, *c.* 1/2-inferior; ovules 3–5 per loculus. *Style* 2.5–3.5 mm long; stigma 0.15–0.2 mm diam. *Fruits* *c.* 1/2 inferior, depressed-globular, 3–3.5 mm long, *c.* 5 mm diam. *Seeds* 1.5–1.7 mm long, 0.6–0.8 mm wide, *c.* 0.8 mm deep including inner protrusion, medium to dark brown; inner protrusion 1.35–1.4 mm long, 0.45–0.5 mm wide; hilum towards base of inner surface, 0.3–0.4 mm diam. *Chaff pieces* 1.1–1.2 mm long.

Diagnostic characters. *Young stems* \pm terete, minutely tuberculate. *Leaves* shortly petiolate; blade narrowly ovate to elliptic. *Petals* 6–8 mm long. *Stamens* 35–55. *Longest filaments* 3–4 mm long. *Ovary* 3-locular; ovules 3–5 per loculus. *Seeds* 1.5–1.7 mm long, medium to dark brown.

Selected specimens examined. WESTERNAUSTRALIA: [localities withheld for conservation reasons] 20 Sep. 1948, *C.A. Gardner* 9154 (PERTH); 16 Sep. 1990, *C.R. Hart* 11 (PERTH); 1 Nov. 1975, *K.R. Newbey* 4906 (PERTH); 22 Sep. 2011, *D.A. Rathbone* DAR 712 (PERTH).

Distribution and habitat. Occurs in Fitzgerald River National Park in the Esperance Plains bioregion (Figure 4), in heath on red soil over quartzite.

Phenology. Flowers have been recorded from September to February and fruits from October to February.

Conservation status. Listed as Priority Two under the Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–). The precise extent of the distribution of *H. melaleuroides* is uncertain as two collections lack exact localities, but the species occurs in a large national park and is only known from a small area that appears to be about 20 km long.

Vernacular name. Fitzgerald Myrtle.

Affinities. This very distinctive species is closest in its morphology to *H. inopinatum*. Apart from the differences used in the key it has narrower leaves and tends to be a lower shrub.

Notes. The species was listed in Paczkowska and Chapman (2000: 387) as '*Hypocalymma melaleuroides* Keighery & Strid ms'. It has the smallest flowers in sect. *Grandiflora* but still among the largest found in the genus. More material is needed to give a more complete description of the flowers, as each specimen has very few flowers and only one has good, fully opened flowers.

Hypocalymma polyandrum Rye, Keighery & M.D.Barrett, *sp. nov.*

Type: east of Cadoux, Western Australia [precise locality withheld for conservation reasons], 1 December 2008, *M.E. Trudgen* MET 23335 (*holo:* PERTH 08215294; *iso:* CANB, K, MEL, NSW).

Hypocalymma puniceum subsp. Cadoux (H. Demarz 10533), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 8 March 2022].

Shrub usually low and spreading, 0.15–1.5 m high, 0.8–2 m wide. *Young stems* whitish, 4-angled and deeply 4-ridged to slightly 4-winged at first, moderately to very rugose, sometimes with very prominent oil gland swellings. *Leaves* antrorse or widely spreading. *Petioles* poorly or well defined, 0.4–1 mm long. *Leaf blades* linear in outline, 10–13 mm long, 0.6–1 mm wide, 0.6–1.2 mm thick, concolorous, obtuse, entire; abaxial surface convex or deeply convex, grooved along the middle, with 1 or 2 main rows of usually very prominent, widely spaced oil glands on each side of the groove, the innermost rows with 9–14 glands; adaxial surface \pm flat, grooved along the middle; apical point recurved, 0.15–0.25 mm long. *Peduncles* borne at 1–3 nodes per branchlet but commonly just one node, 1-flowered, 0.4–1 mm long. *Bracteoles* shed in late bud or in flower, 1.5–2.5 mm long, obtuse. *Pedicels* \pm absent. *Flowers* 19–23 mm diam. *Hypanthium* 1–1.5 mm long, 3–3.5 mm diam.; free part absent or up to 0.4 mm long. *Sepals* usually depressed ovate to almost circular, with the margin incurved, 3–4.5 mm long, 3–4.5 mm wide, with a green herbaceous base surrounded by a pink area, with a white or pale pink margin 0.3–0.5 mm wide. *Petals* 8–11.5 mm long. *Stamens* 75–130. *Longest filaments* 3.5–4.5 mm long, united for *c.* 0.3 mm at base. *Anthers* 0.5–0.6 mm long. *Ovary* 2-locular, *c.* half-inferior; ovules 3 or 4 per loculus. *Style* 4.5–5 mm long; stigma 0.15–0.2 mm diam. *Fruits* largely to almost fully superior, depressed ovate to transversely elliptic from side view, somewhat compressed from top view, 3.2–3.5 mm long, 4–5 mm wide; hypanthium somewhat rugose. *Seeds* 2–2.5 mm long, 1.3–1.5 mm wide, 1.3–1.5 mm deep including inner protrusion, very pale at first, becoming golden brown; inner protrusion 1.5–1.6 mm long, 1.1–1.4 mm wide; hilum *c.* 0.5 mm across. *Chaff pieces* 1.3–1.6 mm long. (Figure 1B)

Diagnostic characters. *Young stems* moderately to very rugose. *Leaf blades* linear in outline, thick. *Petals* 8–11.5 mm long. *Stamens* 75–130. *Longest filaments* 3.5–4.5 mm long. *Ovary* 2-locular; ovules 3 or 4 per loculus. *Seeds* 2–2.5 mm long, very pale to golden brown, very minutely reticulate-pitted.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 3 Nov. 2008, *J.M. Collins* 566 & 568 (PERTH); 15 Oct. 2013, *A. Crawford* ADC 2376 (PERTH); 15 Oct. 2013, *R. Davis, A.J. Perkins & B.L. Rye* DPR 12 (AD, PERTH); 20 Dec. 1984, *H. Demarz* 10533 (CANB, PERTH); Mar.–Apr. 1960, *B. Rosier* 267 (PERTH); 30 May 1985, *B.H. Smith* 575 (CBG, HO, MEL, NSW, PERTH); 16 Nov. 1996, *L. Sweedman* S 4375 (PERTH).

Distribution and habitat. Extends from Kirwan south to near Manmanning in the Avon Wheatbelt bioregion (Figure 4) on yellow sand, on sand over lateritic or with gravel, often in mallee shrubland.

Phenology. Flowers have been recorded from April to December. Young or mature fruits are present on most of the specimens, i.e. apparently throughout the flowering season.

Conservation status. Listed as Priority One under the Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *H. puniceum* subsp. Cadoux (H. Demarz 10533). Its known distribution is *c.* 30 km long.

Etymology. From the Greek *poly-* (many-) and *-andrus* (man, i.e. stamen), as its maximum recorded stamen number of *c.* 130 is the highest known in sect. *Grandiflora* and among the highest in the genus as a whole. Only *H. sylvestre* Strid & Keighery has a significantly larger average stamen number.

Vernacular name. Cadoux Pink Myrtle.

Affinities. This species and its close relative *H. puniceum* are readily distinguished from other species of sect. *Grandiflora* by their narrow, thick leaves and 2-locular ovary. They also differ in having paler seeds with a finer reticulum of pits.

Hypocalymma polyandrum occurs east of the northernmost part of the distribution of *H. puniceum*. It can be readily distinguished from *H. puniceum* by its more numerous stamens and by a combination of vegetative characters, including having fewer oil glands on its mature leaves. Its leaves tend to be much more rugose than in all other members of sect. *Grandiflora*.

Hypocalymma puniceum C.A.Gardner, *J. & Proc. Roy. Soc. Western Australia* 9: 103–104 (1923). *Type:* Bendering, Western Australia, 6 February 1923, *C.A. Gardner* 1922 (*holo:* PERTH 01637169; *iso:* PERTH 01637177, PERTH 01637185, PERTH 01637193, PERTH 02352036).

Illustration. W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildfl.* 3A: 89 (1980).

Shrub 0.1–1 m high, 0.1–1 m wide. *Young stems* 4-angled and deeply 4-ridged to slightly 4-winged, smooth or rarely moderately rugose. *Leaves* mostly appressed or closely antrorse, sometimes some of them widely antrorse. *Petioles* poorly or well defined, 0.4–1 mm long. *Leaf blades* linear in outline, 8–16 mm long, 0.5–1.1 mm wide, 0.5–0.7 mm thick, concolorous, crenulate or entire, obtuse; abaxial surface grooved to convex, with 1 or 2 main rows of moderately closely packed, sometimes prominent oil glands on each side of the groove, the innermost rows with 15–27 glands; adaxial surface \pm flat, narrowly grooved, with 1 main row of sometimes prominent oil glands on each side of the groove; apical point slightly to markedly recurved, 0.2–0.5 mm long. *Peduncles* borne at 1–3(–5) consecutive nodes, mostly 1-flowered (but sometimes with a second abortive flower present), 0.4–1 mm long; secondary axis (when present) 0.5–1.5 mm long. *Bracteoles* usually shed in late bud or in flower, 1.5–3 mm long, often shortly pointed at apex. *Pedicels* \pm absent. *Flowers* 15–30 mm diam. *Hypanthium* 1–1.2 mm long, 3–3.5 mm diam.; free part absent or up to 0.4 mm long. *Sepals* depressed ovate to broadly elliptic, with the margin incurved, 2.5–3.5 mm long, 3–4.5 mm wide, with the green herbaceous base sometimes surrounded by a pink area, with a white or pale pink margin 0.5–0.7 mm wide. *Petals* 9–13 mm long. *Stamens* 35–55. *Longest filaments* 3.5–5 mm long, united for 0.2–0.25 mm at base. *Anthers* 0.35–0.5 mm long. *Ovary* 2-locular, *c.* half-inferior or largely superior; ovules 3 per loculus. *Style* 3.5–5.5 mm long; stigma 0.15–0.2 mm diam. *Fruits* \pm fully superior, depressed ovate to transversely elliptic from side view, somewhat compressed from top view, 2.5–3.5 mm long, 3.5–4.5 mm wide; hypanthium somewhat rugose. *Seeds* 1.6–2.4 mm long, 0.9–1.1 mm wide, 1–1.5 mm deep including inner protrusion, pale to medium golden brown; inner protrusion 1.2–1.5 mm long, 0.5–0.6 mm wide; hilum *c.* 0.4 mm across. *Chaff pieces* 1–1.3 mm long.

Diagnostic characters. *Young stems* smooth to moderately rugose. *Leaf blades* linear in outline, thick. *Petals* 9–13 mm long. *Stamens* 35–55. *Longest filaments* 3.5–5 mm long. *Ovary* 2-locular; ovules 3 per loculus. *Seeds* 1.6–2.4 mm long, very pale to golden brown, very minutely reticulate-pitted.

Selected specimens examined. WESTERN AUSTRALIA: Boolanelling Reserve, between Williams and Copestakes Rds, 9 Apr. 2017, *G. Byrne* 6197 (PERTH); Amery–Benjabeeering Rd, c. 6 km W of Minnivale, 16 July 2009, *J.M. Collins* 615 (PERTH); at gravel pit on Amery–Benjabeeering Rd, W of Minnivale, 15 Oct. 2013, *R. Davis, A.J. Perkins & B.L. Rye* DPR 5 (PERTH); Doyles Rd, 26 km from Kulin Post Office, NW of Kulin, 8 Feb. 2002, *J.P. Francis* 73 (PERTH); 2 miles [3 km] S of Tarin Rocks, 19 Mar. 1970, *M.D. Tindale* 185a & *B.R. Maslin* (A, CANB, K, NSW, PERTH).

Distribution and habitat. Extends from Ballidu in the Avon Wheatbelt bioregion south-east to the Lake Grace area in the Mallee bioregion (Figure 4), with an unconfirmed record from Lake King, on lateritic sand and gravel in shrubland or heath.

Phenology. Flowers have been recorded throughout the year, especially during the summer months. Fruits would therefore also be borne throughout the year.

Conservation status. Not considered to be at risk.

Vernacular name. Large Myrtle.

Typification. In the protologue, Gardner (1923: 104) stated ‘The Type is No. 1922 of the Forests Department Herbarium.’, so the specimen (PERTH 01637169) derived from that herbarium is cited as the holotype. However, Gardner gave the date as 5 February 1923, whereas the holotype and one of the isotypes (PERTH 02352036) give the date as 6 February 1923.

Two other sheets presumed to be isotypes (PERTH 01637185, PERTH 01637193) give the date just as being in February 1923 and have no collection number. The final isotype (PERTH 01637177) has the date as 5 February 1923 and is the only one to give ‘flowers bright pink’ as by Gardner (1923) but has the collection number incorrectly given as 1422.

Affinities. See notes under its close relative *H. polyandrum*.

Notes. *Hypocalymma puniceum* was the only member of the section to have been named prior to the publication of Blackall and Grieve’s (1980) key, in which it is illustrated and accurately keyed on page 89. Like *H. polyandrum*, it has thick leaves, probably as an adaption to its occurrence in drier habitats than those of the other three members of the genus, which have much broader leaves with incurved margins. Its leaves are usually dotted with dark oil glands, which are more or less flush with the surface or moderately prominent. According to Strid and Keighery (2002: 564), *H. puniceum* ‘appears after fires in large numbers then becomes progressively rarer until another fire’. It has also been recorded regenerating from a lignotuber after fires by K. Brooks (pers. comm.).

Hypocalymma puniceum has a short peduncle, 0.4–0.6 mm long, but sometimes has its single viable flower borne on a longer secondary axis, up to 1.5 mm long, which is angled out to one side of the main peduncle. In this case the peduncle also bears an abortive flower on the other side. The lop-sided nature of the 1-flowered peduncles is distinctive and possibly shows evidence of reduction of flower number per peduncle from two to one.

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References

- Anon. (2012). *Hypocalymma*. (In the Master gardeners section of the Friends of Kings Park newsletter) *For People and Plants* 76: 20–21.
- Bentham, G. (1867). *Flora Australiensis*. Vol. 3. (Lovell Reeve & Co.: London.)
- Blackall, W.E. & Grieve, B.J. (1980). *How to know Western Australian wildflowers*. Part 3A. Revised 2nd edn by B.J. Grieve. (University of Western Australia Press: Nedlands.)
- Csaikl, U., Bastian, H., Brettschneider, R., Gauch, S., Meir, A., Schauerte, M., Scholz, F., Sperisen, C., Vornam, B. & Ziegenhagen, B. (1998). Comparative analysis of different DNA extraction protocols: a fast, universal maxi-preparation of high quality plant DNA for genetic evaluation and phylogenetic studies. *Plant Molecular Biology Reporter* 16: 69–86.
- De Lange, P.J., Smissen, R.D., Wagstaff, S.J., Keeling, D.J., Murray, B.G. & Toelken, H.R. (2010). A molecular phylogeny and infrageneric classification for *Kunzea* (Myrtaceae) inferred from rDNA ITS and ETS sequences. *Australian Systematic Botany* 23: 309–319.
- Department of the Environment, Water, Heritage and the Arts (2008). *Interim Biogeographic Regionalisation for Australia (IBRA) Version 6.1*. <http://www.environment.gov.au/parks/nrs/science/bioregion-framework/ibra/index.html>
- Department of the Environment (2022). *Hypocalymma* sp. Cascade (R. Bruhn 20896) in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <https://www.environment.gov.au/sprat>.
- Doyle, J.J. & Dickson, E.E. (1987). Preservation of plant samples for DNA restriction endonuclease analysis. *Taxon* 36: 715–722.
- Elliot, W.R. & Jones, D.L. (1990). *Encyclopaedia of Australian plants suitable for cultivation*. Vol. 9 [Gr–J]. (Lothian Publishing Co. Pty Ltd: Melbourne.)
- Gardner, C.A. (1923). Contributions to the flora of Western Australia, No. 3. *Journal of the Royal Society of Western Australia* 9: 90–105.
- Kearse, M., Moir, R., Wilson, A., Stones-Havas, S., Cheung, M., Sturrock, S., Buxton, S., Cooper, A., Markowitz, S., Duran, C., Thierer, T., Ashton, B., Meintjes, P. & Drummond, A. (2012). Geneious Basic: an integrated and extendable desktop software platform for the organization and analysis of sequence data. *Bioinformatics* 28: 1647–1649.
- Paczkowska, G. & Chapman, A.R. (2000). *The Western Australian flora: a descriptive catalogue*. (Wildflower Society of Western Australia: Nedlands, Western Australia.)
- Posada, D. & Crandall, K.A. (1998). MODELTEST: testing the model of DNA substitution. *Bioinformatics* 14: 817–818.
- Rye, B.L., Wilson, P.G. & Keighery, G.J. (2013). A revision of the species of *Hypocalymma* (Myrtaceae: Chamelaucieae) with smooth or colliculate seeds. *Nuytsia* 23: 283–312.
- Schauer, J.C. (1844). Myrtaceae RBr. In: Lehmann, J.G.C. (ed.) *Plantae Preissianae*. Vol. 1, pp. 96–158. (Meisner: Hamburg.)
- Smith, M.G. & Jones, A. (2018). Threatened and Priority Flora List, 5 December 2018. Department of Biodiversity, Conservation and Attractions: Kensington, WA.
- Stamatakis, A. (2006). RAxML-VI-HPC: maximum likelihood-based phylogenetic analyses with thousands of taxa and mixed models. *Bioinformatics* 22(21): 2688–2690.
- Strid, A. & Keighery, G.J. (2002). A taxonomic review of the genus *Hypocalymma*. *Nordic Journal of Botany* 22: 535–572.
- Western Australian Herbarium (1998–). *Florabase—the Western Australian flora*. Department of Biodiversity, Conservation and Attractions. <https://florabase.dpaw.wa.gov.au/> [accessed 8 March 2022]
- Wilson, P.G. & Heslewood, M.M. (2011). Myrtaceae: progress on all fronts. *XVIII International Botanical Congress (IBC 2011) Abstract Book*. Pp. 326–327.
- Wright S.D., Yong C.G., Wichman S.R., Dawson J.W. & Gardner R.C. (2001). Stepping stones to Hawaii: a trans-equatorial dispersal pathway for *Metrosideros* (Myrtaceae) inferred from nrDNA (ITS + ETS). *Journal of Biogeography* 28: 769–774. doi:10.1046/j.1365-2699.2001.00605.x
- Turczaninow, N. (1862). Decas octava. Generum adhuc non descriptorum. *Bulletin de la Société Impériale des Naturalistes de Moscou* 35(4): 321–325.

***Calytrix calingiri*, a new species from the *Calytrix acutifolia*
species group (Myrtaceae: Chamelaucieae)**

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Abstract

Nge, F.J. & Thiele, K.R. *Calytrix calingiri*, a new species from the *Calytrix acutifolia* species group (Myrtaceae: Chamelaucieae). *Nuytsia* 33: 251–261 (2022). A taxonomic assessment of *Calytrix cravenii* Nge & K.R.Thiele has shown that a distinct morphological variant that occurs near Calingiri in south-west Western Australia is best regarded as a distinct species. It is described here as *Calytrix calingiri* Nge & K.R.Thiele *sp. nov.*

Introduction

Calytrix acutifolia (Lindl.) Craven was segregated into four species in a recent revision of the group by Nge *et al.* (2017). Species within the group lack awns and have white flowers with elongate inflorescences. All four species are endemic in southwest Western Australia and form a monophyletic clade within *Calytrix* based on molecular sequence data (Nge *et al.* 2021). The clade diverged from other *Calytrix* species during the late Miocene (*c.* 10 Ma; Nge *et al.* 2021).

Among the species in the group, *Calytrix cravenii* Nge & K.R.Thiele is most variable in leaf and floral morphology (Nge *et al.* 2017). Specimens from the Calingiri area with distinctly short leaves, petals, and hypanthia were discussed by Nge *et al.* (2017) and tentatively placed within *C. cravenii* pending further study.

Here we assess morphological variation in *C. cravenii* in more detail, both in the field and through morphometric assessment of herbarium specimens, and conclude that the Calingiri specimens are distinct from other populations of *C. cravenii* and its relatives, and are best regarded as representing a fifth species in the group. We provide an updated key to the *C. acutifolia* species group and recircumscribe *C. cravenii* to exclude the Calingiri taxon.

Methods

All available herbarium specimens of *Calytrix cravenii* housed at PERTH were examined to compare morphological variation across its distributional range and assess the distinct morphological variant at Calingiri. Seven leaf and floral characters were measured from representative specimens for quantitative analysis (Table 1), including leaf length and width, petal length, style length, bracteole length, and hypanthium length. Leaf length:width and hypanthium length:bracteole length ratios were calculated. Three measurements were made of each character per specimen using a microscope reticule to the nearest 0.01 mm and average values calculated for each measured specimen.

Morphometric analyses were performed using the Euclidean Distance dissimilarity measure after all characters were range-standardised. Unweighted pair group method with arithmetic mean (UPGMA) clustering and Principal Component Analysis (PCA) ordinations were performed in R (R Core Team 2016) using the `plot.hc` and `prcomp` functions respectively.

Results and Discussion

Both the UPGMA and PCA analyses showed that the Calingiri plants are distinct from typical *C. cravenii* (Figure 1), being distinctly smaller in all measured parts (Table 2). Floral characters are more taxonomically informative than leaf characters in separating the two entities, particularly hypanthium and bracteole lengths and their ratios. While the Calingiri plants overlap slightly in leaf characters with typical *C. cravenii*, they all have consistently shorter leaves than most *C. cravenii*.

Field observations show that the Calingiri plants also differ from typical *C. cravenii* in habit and growth form. The latter grow as abundantly multi-stemmed shrubs that appear to resprout after fire and other disturbances. By contrast, the Calingiri plants are single-stemmed at least when young, and are likely to be obligate reseeders after fire. Very old plants become multi-stemmed at ground level, but not by the growth of new shoots from the rootstock as was observed in *C. cravenii*. Instead, the single stem seen in young plants appears to exhibit anomalous secondary thickening, with broad parenchyma rays in the secondary wood, which cause it to split to ground level as the plants get larger. Single-stemmed plants becoming multi-stemmed by splitting in this way have been observed in other genera and families (e.g. *Hibbertia*, some Myrtaceae); this unusual stem morphology is worthy of further investigation.

The two species appear to have different flowering times, with typical *C. cravenii* mostly in bud when the Calingiri plants are at peak flowering.

One specimen from Collie (*L. Dodd s.n.* PERTH 02157195) falls within the group comprising the Calingiri form in both the UPGMA and PCA analyses (Figure 1) but is geographically widely disjunct. It is also somewhat disjunct from typical *C. cravenii*. The specimen was collected from a road verge, and the collector speculated that it may have been introduced to the area. Field visits are required to determine the taxonomic status of the population or individual. It is tentatively assigned to the Calingiri form here, pending further studies.

Given the consistent differences between *C. cravenii* and the Calingiri form, we recognise the latter as the new species *Calytrix calingiri* Nge & K.R.Thiele, and recircumscribe *C. cravenii* to exclude it.

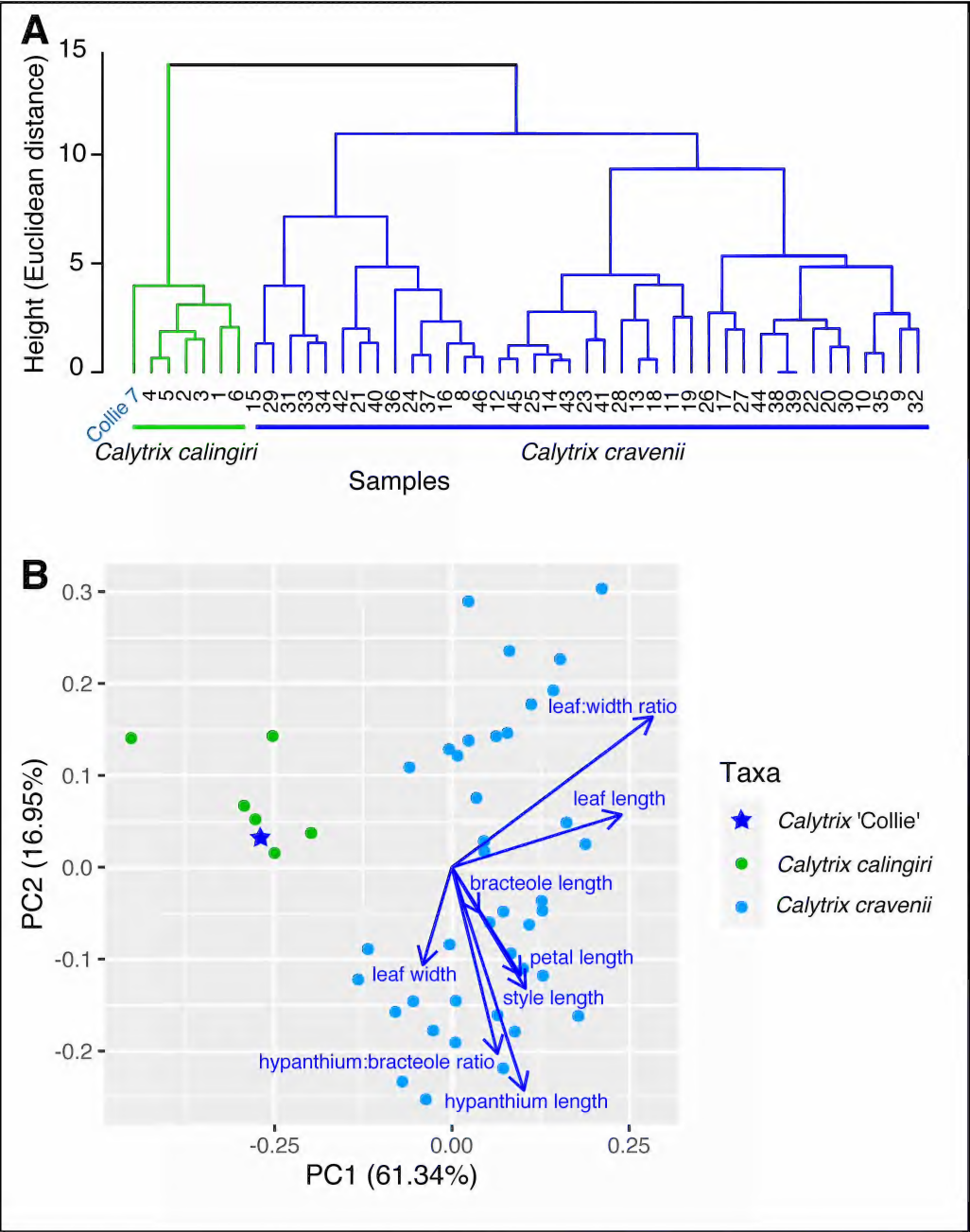


Figure 1. Morphometric analyses of floral and leaf characters from PERTH herbarium specimens of *C. calingiri* and *C. cravenii*. A – Unweighted pair group method with arithmetic mean (UPGMA) dendrogram; B – 2D Principal Components Analysis (PCA) ordination analysis, with arrows indicate the respective character and direction of separation between clusters.

Table 1. PERTH voucher specimens measured and included in Unweighted pair group method with arithmetic mean (UPGMA) and Principal Components Analysis (PCA) ordination analyses.

| Number | Taxa | Voucher |
|--------|---------------------------|----------------|
| 1 | <i>Calytrix calingiri</i> | PERTH 02157071 |
| 2 | <i>Calytrix calingiri</i> | PERTH 02157160 |
| 3 | <i>Calytrix calingiri</i> | PERTH 02157276 |
| 4 | <i>Calytrix calingiri</i> | PERTH 06060935 |
| 5 | <i>Calytrix calingiri</i> | PERTH 07185367 |
| 6 | <i>Calytrix calingiri</i> | PERTH 08430357 |
| 7 | <i>Calytrix</i> ‘Collie’ | PERTH 02157195 |
| 8 | <i>Calytrix cravenii</i> | PERTH 01179926 |
| 9 | <i>Calytrix cravenii</i> | PERTH 01232649 |
| 10 | <i>Calytrix cravenii</i> | PERTH 01560581 |
| 11 | <i>Calytrix cravenii</i> | PERTH 01750348 |
| 12 | <i>Calytrix cravenii</i> | PERTH 02157004 |
| 13 | <i>Calytrix cravenii</i> | PERTH 02157063 |
| 14 | <i>Calytrix cravenii</i> | PERTH 02157179 |
| 15 | <i>Calytrix cravenii</i> | PERTH 02157187 |
| 16 | <i>Calytrix cravenii</i> | PERTH 02157225 |
| 17 | <i>Calytrix cravenii</i> | PERTH 02157268 |
| 18 | <i>Calytrix cravenii</i> | PERTH 02157403 |
| 19 | <i>Calytrix cravenii</i> | PERTH 02157411 |
| 20 | <i>Calytrix cravenii</i> | PERTH 02157438 |
| 21 | <i>Calytrix cravenii</i> | PERTH 02157446 |
| 22 | <i>Calytrix cravenii</i> | PERTH 02157454 |
| 23 | <i>Calytrix cravenii</i> | PERTH 02157497 |
| 24 | <i>Calytrix cravenii</i> | PERTH 02157500 |
| 25 | <i>Calytrix cravenii</i> | PERTH 02157519 |
| 26 | <i>Calytrix cravenii</i> | PERTH 02157624 |
| 27 | <i>Calytrix cravenii</i> | PERTH 03118630 |
| 28 | <i>Calytrix cravenii</i> | PERTH 03174786 |
| 29 | <i>Calytrix cravenii</i> | PERTH 04426797 |
| 30 | <i>Calytrix cravenii</i> | PERTH 04669258 |
| 31 | <i>Calytrix cravenii</i> | PERTH 04936434 |
| 32 | <i>Calytrix cravenii</i> | PERTH 05027667 |
| 33 | <i>Calytrix cravenii</i> | PERTH 05120217 |
| 34 | <i>Calytrix cravenii</i> | PERTH 05205050 |
| 35 | <i>Calytrix cravenii</i> | PERTH 05505771 |

Table 1. cont.

| Number | Taxa | Voucher |
|--------|--------------------------|----------------|
| 36 | <i>Calytrix cravenii</i> | PERTH 05997895 |
| 37 | <i>Calytrix cravenii</i> | PERTH 06331297 |
| 38 | <i>Calytrix cravenii</i> | PERTH 06742351 |
| 39 | <i>Calytrix cravenii</i> | PERTH 06828701 |
| 40 | <i>Calytrix cravenii</i> | PERTH 07197179 |
| 41 | <i>Calytrix cravenii</i> | PERTH 07213751 |
| 42 | <i>Calytrix cravenii</i> | PERTH 07779577 |
| 43 | <i>Calytrix cravenii</i> | PERTH 07811705 |
| 44 | <i>Calytrix cravenii</i> | PERTH 07868642 |
| 45 | <i>Calytrix cravenii</i> | PERTH 07868707 |
| 46 | <i>Calytrix cravenii</i> | PERTH 08076030 |

Table 2. Morphological comparison of measured quantitative characters between *Calytrix cravenii*, *C. calingiri*, and the Collie specimen discussed in the text.

| Character | <i>C. cravenii</i> | Calingiri form | Collie specimen |
|---|--------------------|----------------|-----------------|
| Leaf length (mm) | 4.4–10.5 | 2.6–3.9 | 4.7 |
| Leaf length:width ratio | 9.5–26.0 | 5–8.5 | 6.6 |
| Hypanthium length (mm) | 2.8–5.0 | 2.1–2.9 | 2.4 |
| Hypanthium: bracteole length ratio | 0.97–1.8 | 0.7–0.9 | 0.9 |
| Petal length (mm) | 3.8–7.8 | 3.8–5 | 4.2 |
| Style length (mm) | 2.4–6.5 | 2.6–4.6 | 3.7 |
| Inflorescence length (mm) | 30–125 | 20–50 | n/a |

Key to species of the *Calytrix acutifolia* species group

1. Bracteoles with translucent wings that extend to and overlap to the apex, covering $> 3/4$ the length of the hypanthium; corolla 7.5–10 mm long; leaf blades 0.6–1.1 mm wide, with a distinct, protruding adaxial midrib, depressed-triangular in T.S. with a concave adaxial surface (Lesmurdie–Oakley)..... **C. acutifolia**
- 1: Bracteoles with translucent wings reduced, the hypanthium clearly visible, or with translucent wings that extend and overlap for $< 1/2$ the length of the hypanthium; corolla < 7 mm long; leaf blades < 0.6 mm wide, lacking a protruding adaxial midrib, depressed-triangular to obovate in TS..... **2**
2. Leaf blades obtriangular to depressed-obtriangular in TS, glabrous to prominently ciliate on margins, the hairs 0.05–0.2 mm long; stems with hairs 0.05–0.15(–0.2) mm long (Dongara–Narrogin) **3**
- 2: Leaf blades depressed angular-obovate in TS, glabrous to sparsely ciliate on margins, the hairs to 0.05 mm long; stems with hairs 0.2–0.5 mm long **4**
3. Bracteoles and sepals longer than the hypanthium, which is 2.1–2.9 mm long; mature inflorescences 20–50 mm long; leaf blades 2.6–3.9 mm long; leaf length:width ratio 5–8.5; plants single-stemmed at base, at least when young (Calingiri area)..... **C. calingiri**
- 3: Bracteoles and sepals usually shorter than the hypanthium, which is 2.8–5.0 mm long; mature inflorescences (30–)50–125 mm long; leaf blades 4.4–10.5 mm long; leaf length:width ratio 9.5–26.0; plants abundantly multi-stemmed at base, at least when mature (Dongara–Narrogin) **C. cravenii**
4. Hypanthium (2–)2.5–3.5 mm long, mostly 6–8-ribbed, smooth to somewhat rugose between the ribs; leaves patent at maturity (Yallingup–Esperance)..... **C. hirta**
- 4: Hypanthium 1.5–2 mm long, 5-ribbed, markedly rugose between the ribs; leaves reflexed at maturity (Busselton–Tutunup)..... **C. retrorsifolia**

Taxonomy

Calytrix cravenii Nge & K.R.Thiele, *Nytsia* 28: 330 (2017).

Lhotskya scabra Turcz., *Bull. Soc. Imp. Naturalistes Moscou* II. 324 (1862). Type: ‘Nova Hollandia. Gilbert n. 186.’ (lecto: KW 1001262 image!, inadvertently designated by L. Craven, *Austral. Syst. Bot.* 10: 122 (1987); isolecto: K 821950 image!).

Calytrix sp. Eneabba (B.J. Lepschi & T.R. Lally BJL3617), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 14 December 2016].

Calytrix sp. Wheatbelt (R. Davis 4544), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 14 December 2016].

Erect, open *shrubs* 0.5–2 m high, multi-stemmed at base and presumably resprouting after fire. *Young stems* abundantly pilose with hairs 0.05–0.15(–0.2) mm long, mottled cream and pale brown or red-brown on new growth, with prominent leaf scars on older stems. *Leaves* alternate to partially subopposite; foliar colleters absent; petioles 0.5–1 mm long, yellow, glabrous to ciliate; blades linear to linear-oblancheolate, (4.4–)6–8(–10.5) mm long, 0.35–0.58(–0.73) mm wide, depressed-triangular in TS, glabrous to prominently ciliate with hairs 0.05–0.2 mm long; oil glands usually absent, sometimes noticeable; apex acute to obtuse. *Inflorescences* (30–)50–125 mm long, extending to 2–10

mm below shoot apex at anthesis; peduncles 0.5–0.8 mm long; bracteoles green to light brown, ciliate along midrib, (2.3–)2.8–3.5(–4) mm long, free or slightly connate at base, with entire margins, long-acuminate apex, and translucent wings reduced and scarcely overlapping. *Flowers* 5-merous, c. 10–15 mm diam.; hypanthium 5-ribbed, subcylindrical, 2.8–5 mm long, usually longer than the bracts and exposed above them, smooth or rugose-pitted between the ribs, glabrous to finely ciliate, with two rows of hairs along each rib; sepals 0.6–1.1 mm long, 0.4–0.8 mm wide, glabrous, the margin erose, the apex obtuse-truncate, lacking awns; petals (3.8–)5–6.5(–7.8) mm long, (1–)1.5–1.7 mm wide, white (pale yellow in bud), glabrous; staminodes absent; stamens 18–29, white, 2-seriate, the longest filaments 4–5 mm long, the anthers 0.2–0.3 mm long; style (2.4–)5(–6.5) mm long, white. *Seeds* not seen. (Figure 2A, 3E–G)

Selected specimens examined. WESTERN AUSTRALIA: Site Gch 1, 10 km SW of Goomalling on Goomalling–Toodyay Road, 24 Oct. 1993, *P. Armstrong* s.n. (PERTH); private property, 11 km S of Pingelly, E side of railway, 28 Oct. 1995, *D. Box* PGY DB143 (PERTH); north side of Robinson Road – just W of Arrowsmith River Crossing, c. 42 km S of Mingenew, 8 Oct. 1992, *A. Carr* 131 (PERTH); 9.5 miles from Three Springs on Eneabba road, 15 Oct. 1978, *C. Chapman* (18)78 (PERTH); 6 km SE of Kweda, 21 Oct. 1983, *R.J. Cranfield* 4518 (PERTH); 8 km S of Marchagee and 8 km along the road off to the west, 28 Oct. 1981, *L.A. Craven* 7310 (PERTH); Popanyinning, between town and rail crossing S of town, 8 Nov. 1981, *L.A. Craven* 7436 (PERTH); Barberton West Road, SW of Moora, 28 Sep. 2007, *A. Crawford* ADC 1348; Duranillin–Bowelling Road, 1 km W of Duranillin, 18 Nov. 1997, *R. Davis* 4544 (PERTH); road verge – introduced, Collie area, May 1972, *L. Dodd* (A) (PERTH); Great Southern Highway, 2.6 km SE of Hotham River crossing, 4.3 km due N of Popanyinning, 23 Nov. 1988, *J.M. Fox* 88/332 (PERTH); Boothendarra Hill Reserve (29719), N of Badgingarra AMG 50JLM613503 (Badgingarra 1:50,000 sheet), 24 Sep. 1988, *E.A. Griffin* 5253 (PERTH); Boonanarring Nature Reserve, Gingin, on the western boundary c. 1.45 km S of Wannamal West Road, 27 Oct. 2001, *F. Hort, J. Hort, B. & B. Backhouse* 1577 (PERTH); W side of the Wongan Hills, c. 200 km NE of Perth, 29 Oct. 1980, *K.F. Kenneally* 7511 (PERTH); Mortlock River crossing on Bolgart East Road, c. 3 km ENE of Smith Road turnoff, c. 8.5 km NW of Goomalling, 21 Oct. 1997, *B.J. Lepschi*



Figure 2. A – *Calytrix cravenii* (F. Nge 610); B – *C. calingiri* (F. Nge 619). Photographs by F. Nge.

& T.R. Lally 3617 (PERTH); spring-fed creek 30 km NE of Eneabba on edge of unnamed NR A12705, E side of Skipper Road 4 km NNE of intersection of Bunney Road and Skipper Road. SAP wetlands site SPS180B, 23 Sep. 1999, M.N. Lyons & S.D. Lyons 3534 (PERTH); Jingaring Nature Reserve, Jingaring road, c. 30 km ENE of Pingelly, 7 Nov. 1999, L.W. Sage, R. Davis & F. Obbens LWS 1328 (PERTH); 43 km S of the Brand Highway and Midlands Highway junction, S Dongara, 14 Nov. 2008, L.S.J. Sweedman 7587 (PERTH); wasteland along Hotham River near where it crosses Brookton Highway [the Hotham River crosses the Great Southern Highway near Carraching], 10 Nov. 2002, G. Warren & P. Rose 686 (PERTH).

Phenology. Flowers in spring to early summer, from September to December, with a peak from mid-October to November.

Distribution and habitat. Wide-ranging, found in a range of habitats in the Geraldton Sandplains and Avon Wheatbelt bioregions, from Dongara to Wongan Hills, south to Narrogin (Figure 4), commonly on white, grey, or yellow sandplains with associated kwongan heath or low woodland vegetation communities. A few populations are found near riverbanks and valleys, on dry white sand or damp sandy clay along drainage lines.

Conservation status. Not considered to be at risk; widespread throughout its range although many populations are found on road verges where little native vegetation remains.

Notes. *Calytrix cravenii* flowers later than *C. calingiri*, with a peak in November compared to *C. calingiri* which mainly flowers in spring (peak in September). A noticeable difference in the field between *C. cravenii* and *C. calingiri* is their growth habit, with *C. cravenii* abundantly suckering from the rootstock (as in other members of the *C. acutifolia* complex) while *C. calingiri* plants are single-stemmed at the base and ‘tree-like’ when young (Figure 3). The suckering shrub habit of *C. cravenii* suggests that this species likely resprouts after fire, but this has not been directly observed.

Calytrix calingiri Nge & K.R.Thiele, *sp. nov.*

Type: Calingiri, Western Australia [precise locality withheld for conservation reasons], 21 September 2019, F.J. Nge & K.R. Thiele 1080 (*holo:* PERTH 09446249; *iso:* AD, CANB, K, MEL, NY).

Erect, open *shrubs* 0.5–2 m high. *Young stems* pilose with hairs 0.05–0.1 mm long, mottled cream and pale brown or red-brown on new growth, with prominent leaf scars on older stems. *Leaves* alternate to partially subopposite; foliar colleters absent; petioles 0.4–0.7 mm long, yellow, glabrous to ciliate; blades linear to linear-oblongate, 3–11 mm long, 0.3–0.9 mm wide, depressed-triangular in T.S., glabrous to prominently ciliate with hairs c. 0.1 mm long; oil glands usually absent, sometimes noticeable; apex acute to obtuse. *Inflorescences* 20–50 mm long, extending to 2–10 mm below shoot apex at anthesis; peduncles 0.1–0.3 mm long; bracteoles green to light brown, ciliate along midrib, 2–3.2 mm long, free to slightly connate at base, with entire margins and long-acuminate apex, the translucent wings reduced and scarcely overlapping. *Flowers* 5-merous, c. 8.5–10(–11) mm diam.; hypanthium 5-ribbed, subcylindrical, 2–2.9 mm long, usually shorter than and covered by the bracts, smooth or rugose-pitted between the ribs, glabrous to finely ciliate, with two rows of hairs along each rib; sepals 0.25–0.5 mm long, c. 0.5 mm wide, glabrous, the margin erose, the apex obtuse-truncate, lacking awns; petals 3.8–4.5(–5) mm long, 0.8–1.3 mm wide, white (pale yellow in bud), glabrous; staminodes absent; stamens 18–29, white, 2-seriate, the longest filaments 4–4.6 mm long, the anthers 0.2–0.3 mm long; style 2.6–4.6 mm long, white. *Seeds* not seen. (Figure 2B, 3A–D)



Figure 3. Growth forms of *Calytrix* spp. A–D *Calytrix calingiri* (F. Nge 619) – compact single-stemmed tree of all ages (young–mature); E–G *C. cravenii* – spreading shrub (E–F: F. Nge 1049; G: F. Nge 610). Photographs by F. Nge.

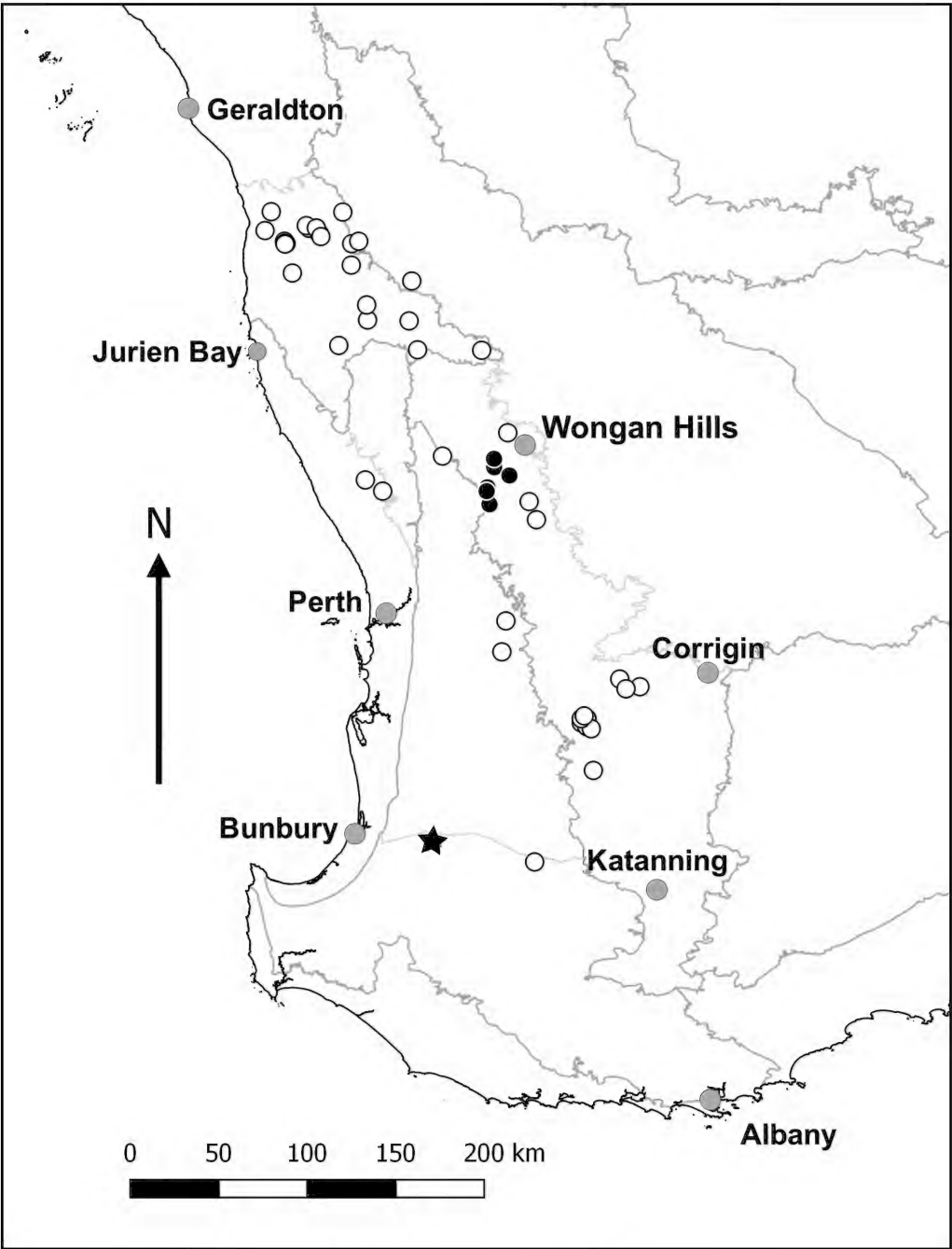


Figure 4. Distribution of *Calytrix calingiri* (●), *C. cravenii* (○), and *C. 'Collie'* (★) in south-west Western Australia.

Diagnostic features. *Calytrix calingiri* is smaller in floral and leaf characters than *C. cravenii*. The following combination of characters can be used to differentiate *C. calingiri* from *C. cravenii*: bracteoles and sepals covering the hypanthium (i.e. hypanthium:bracteole length ratio < 1 , usually 0.7–0.9); hypanthium 2.1–2.9 mm long; petals 3.8–4.5 mm long; mature inflorescence 20–50 mm long; leaf blades 2.6–3.9 mm long; leaf length:width ratio 5–8.5.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 30 Aug. 1971, *T.E.H. Aplin* 4881 (PERTH); Aug. 1938, *Erickson s.n.* (PERTH); 6 Aug 2005, *F. Hort & J. Hort* FH 2568 (PERTH); 21 Sep. 2019, *F.J. Nge & K.R. Thiele* 1081 (PERTH); 6 Oct. 2018, *F. Nge & L.J.R. Shelton* 619 (AD); 6 Oct. 2018, *F. Nge & L.J.R. Shelton* 623 (AD 284797); 10 Sep. 1974, *Powell* 74087 (PERTH); 22 Sep. 1955, *Royce* 5151 (PERTH); 9 Dec. 2018, *K.R. Thiele* 4006 (PERTH).

Phenology. Flowers in late winter to spring, from August–October, with a peak in September.

Distribution and habitat. *Calytrix calingiri* has a localised distribution around Calingiri (Figure 4), where it is associated with kwongan and wandoo woodlands on dry white sand or sandy loam. Its distribution falls within that of *C. cravenii*, with the shortest distance between populations of the two species c. 20 km. There is no indication that nearby populations of *C. cravenii* are more similar to *C. calingiri* than they are to more distant ones.

An outlying specimen from the Collie area (*L. Dodd s.n.* PERTH 02157195) may have been introduced with road materials, as it is well to the west of the main distribution and is the only collection known to occur in the Jarrah Forest bioregion.

Conservation status. Restricted in range, currently only known to occur in one Nature Reserve; many populations are found along road verges. To be listed as Priority Three under Conservation Codes for Western Australian Flora (Tanya Llorens pers. comm.).

Etymology. From the place-name Calingiri, used as a noun in apposition.

Notes. See notes under *C. cravenii*.

Acknowledgements

We thank the Curator and staff of the Western Australian Herbarium for access to specimens and facilities. We also thank Lindsay Shelton for assistance and company during our field visits to populations of *C. calingiri*. Fieldwork to collect voucher specimens and DNA material was supported by the South Australian Department of Environment, Water and Natural Resources (grant D0004335204).

References

- Nge, F.J., Biffin, E., Waycott, M. & Thiele, K.R. (2021). Phylogenomics and continental biogeographic disjunctions: insight from the Australian starflowers (*Calytrix*). *American Journal of Botany* 109: 291–308.
- Nge, F.J., Keighery, G.J. & Thiele, K.R. (2017). A revision of the *Calytrix acutifolia* complex (Myrtaceae: Chamelaucieae). *Nuytsia* 28: 321–337.
- R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. <https://www.r-project.org/>

A new species of *Brachyachne* (Poaceae: Chloridoideae: Cynodonteae) from semi-arid Northern Territory and Western Australia, and additional notes on the genus

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Abstract

Albrecht, D.E. & McLay, T.G.B. A new species of *Brachyachne* (Poaceae: Chloridoideae: Cynodonteae) from semi-arid Northern Territory and Western Australia, and additional notes on the genus. *Nuytsia* 33: 263–274. *Brachyachne anisocarpa* Albr. is described and illustrated, with notes on distribution, habitat and relationship with similar species. New distribution records of other *Brachyachne* (Benth.) Stapf species are provided, along with a key to *Brachyachne* species in Australia. The status of the genus is discussed based on an analysis of pre-existing and new molecular data.

Introduction

Until recently, the grass genus *Brachyachne* (Benth.) Stapf (subfamily Chloridoideae, tribe Cynodonteae) was considered to comprise approximately 11 species, dispersed throughout parts of Africa, tropical Asia and Australia. However, molecular studies published recently (Peterson *et al.* 2010, 2015) have proposed a disintegration of the genus, with the African species transferred to a new genus *Micrachne* P.M.Peterson, Romasch. & Y.Herrera, and the five remaining species (*Brachyachne* s. str.), all of which occur in Australia, subsumed into *Cynodon* Rich. Currently the proposed merger of non-African *Brachyachne* species with *Cynodon* has been formally adopted by only some Australian herbaria. The most comprehensive contemporary treatment of *Brachyachne* s. str. by Nightingale *et al.* (2005) recognises five species for Australia – four native (*B. ciliaris* (Kuntze) C.E.Hubb., *B. convergens* (F.Muell.) Stapf, *B. prostrata* C.A.Gardner & C.E.Hubb. and *B. tenella* (R.Br.) C.E.Hubb.) and one introduced from Asia (*B. ambigua* Ohwi).

In the mid to late 1990s, two populations of an apparently undescribed *Brachyachne* species were found whilst undertaking fieldwork in the Tanami bioregion of the Northern Territory. Collections made from these sites matched a specimen from the eastern Kimberley region of Western Australia collected in 1980 by John Petheram and housed at the Alice Springs Herbarium (NT). A colour photograph of the Western Australian plants *in situ* appears in Petheram and Kok (1983: 68–69) under the name *B. ciliaris*. Recent field work in the Northern Territory, coupled with cultivation of plants grown from soil seed bank samples, has confirmed the distinctiveness of these populations, which are described here as the new species *Brachyachne anisocarpa* Albr.

Methods

Morphology. This study was based on an examination of plants in their wild occurrence, cultivated plants and dried specimens housed at CANB, NT and BRI. Obtaining sufficient material of the new species from the field at the right developmental stage for comparative study, description and typification proved to be difficult. To overcome this problem, soil seed bank samples were collected at two sites in the Northern Territory during May 2017 in the vicinity of disintegrating dead plants of the new species. The soil samples were laid on trays in a greenhouse at the Australian National Botanic Gardens (ANBG) nursery in Canberra and watered over the summer of 2017–2018. Germinants were potted up and grown on until spikelets showed signs of having mature caryopses. To facilitate reliable comparison between the new species and other *Brachyachne* species, some numerical characters previously used in the genus, and one new character, needed to be measured in a consistent way. Inflorescence branch axis width was measured at an internode approximately halfway along its length. Glume wing width was measured at its widest point, as the distance between the outer edge of the green midvein and the outer wing edge. The distance separating palea keels was assessed on fruiting specimens.

DNA extraction, PCR amplification, and phylogenetic analysis. DNA was extracted from samples of *Brachyachne anisocarpa* (including the type specimen) and *B. prostrata* (see Table 1 for sample details) using the Plant/Fungi DNA isolation kit (Sigma-Aldrich) or Invisorb Plant Mini Kit (Stratec). ITS1 and ITS2 amplicons were amplified separately using universal plant primers (see Chen *et al.*

Table 1. Details of the newly sequenced *Brachyachne* samples.

| Species | Collector ID (herbarium accession number) | Locality | GenBank sequence ID |
|--|---|--|------------------------|
| <i>Brachyachne anisocarpa</i> <i>sp. nov.</i> | D.E. Albrecht 15234 (CANB 905223 – type) | Cultivated Australian National Botanic Gardens nursery, ex Northern Territory, Stuart Hwy 25.5 km due SSE of Renner Springs roadhouse | OK380945 |
| | D.E. Albrecht 15238 (CANB 905227) | Cultivated Australian National Botanic Gardens nursery, ex Northern Territory, Stuart Hwy c. 1.9 km N of intersection with Mary Ann Dam Road, N of Tennant Creek | OK380946 |
| <i>Brachyachne prostrata</i> | D.E. Albrecht 14631 & P.K. Latz (CANB 892239) | Western Australia, Kiwirrkurra Indigenous Protected Area; c. 800 m S of the Gary Junction Road, c. 31.7 km due WNW of the NT/WA border on the Gary Junction Road | OK380944 |
| | P.K. Latz 3962 (CANB 244479) | Northern Territory, Coomarie Spring | OK380947 |

2010), and the amplicons were sequenced using Sanger sequencing on an ABI 3730xl DNA Analyser (Macrogen, South Korea). Sequences were imported into Geneious Prime for editing, and the two amplicons were merged using Ns to fill a missing portion of the 5.8S region. To determine the closest relative of *B. anisocarpa* and assess the validity of the genus, the five-locus alignment from Peterson *et al.* (2015) was imported into Geneious, and the new sequences were incorporated. To reduce the size of the alignment, taxa were removed so that only species of *Cynodon* and *Brachyachne*, plus species from closely related genera *Stapfchloa* H.Scholz, *Chrysochloa* Swallen, *Eustachys* Desv., and *Micrachne* were retained, with *Oxychloris scariosa* (F.Muell.) Lazarides serving as an outgroup (based on the topology of Peterson *et al.* 2010). To reduce the impact of missing data on the supermatrix phylogeny, samples that were represented by a single locus were removed from the dataset (except for the new *Brachyachne* sequences), and the alignment was realigned. The final alignment included 79 samples, was 4,133 bp long, and was partitioned into seven loci (*rpl32*, *ndhA*, *rps16* intron, *rps16* gene, ITS1, 5.8S, ITS2) for phylogenetic analysis. The alignment was analysed using RAxML v. 8 (Stamatakis 2014), with 10 maximum likelihood searches under the GTRCAT model, and with bootstrap support values from 1000 rapid bootstraps then mapped onto the best tree as defined by likelihood scores.

Taxonomy

***Brachyachne anisocarpa* Albr., sp. nov.**

Typus: Cultivated Australian National Botanic Gardens nursery, 28 February 2018, D.E. Albrecht 15234 (*holo*: CANB 905223; *iso*: AD, BRI, DNA, K, MEL, NSW, NT, PERTH).

Tufted annual, sometimes producing adventitious roots at the lower nodes. *Flowering culms* erect or geniculate ascending to c. 16 cm high, usually branching near or occasionally above the base; internodes wiry, 0.2–1.0 mm diameter, \pm maroon tinged; nodes glabrous. *Leaves* basal and cauline, the uppermost cauline leaf usually bladeless or with a reduced blade. *Leaf sheaths* glabrous abaxially or with a few hairs to c. 2 mm long concentrated on the distal margins/sub-margins near the ligule, \pm maroon tinged. *Ligule* a minutely ciliate membrane; membrane 0.2–0.5 mm long; cilia to c. 0.15 mm long. *Leaf blades* lanceolate, 5–56 mm long, 1–4 mm wide, flat *in vivo*, sometimes folded about midvein when dry, narrowly acute, adaxially with short hairs to 0.1 mm long and sparse spreading longer hairs to c. 2.5 mm long or rarely glabrous, abaxially glabrous or scaberrulous particularly in the distal half; margin serrulate-scabrous; collar conspicuous, \pm maroon tinged, \pm with few long hairs on adaxial and/or abaxial side near margin. *Inflorescence* well exerted from uppermost leaf sheaths; branches (1–)2(–3), 9–25 mm long, long-persistent but finally disarticulating, initially straight to slightly curved and diverging (thus inflorescence and culm apex collectively appearing Y- or T-shaped), later deflexing as spikelets fall, finally strongly decurved, each with a minutely hairy basal pulvinus to 1 mm long; axis 0.5–0.8 mm wide, flattened, with a prominent usually zig-zagged central nerve and several parallel finer nerves on the wing-like portion on either side of the central nerve. *Spikelets* arranged secundly on the underside of the inflorescence branches in 2 rows, 13–33 per inflorescence branch, sessile, strongly laterally compressed, elliptic or narrowly obovate, 2.3–3(–3.2) mm long, disarticulating below the glumes; barren rachilla extension 0.8–1.2 mm long, terminated by a minute tuft of hairs. *Glumes* 2.3–3(–3.2) mm long, subequal or the upper or lower slightly longer, obtuse, \pm minutely notched, with a green midnerve and maroon tinged sides, finally turning stramineous; lower glume curved in profile, carinate with keel wingless or with a very narrow wing <0.05 mm wide, inconspicuously scaberrulous on nerve or wing; upper glume \pm straighter than the lower glume in profile, round on back but with central nerve becoming raised in dried material, smooth on central nerve. *Callus* rather indistinct, to 0.2 mm long, shortly hairy, acute. *Lemma* narrowly elliptic in dorsal view, oblanceolate in profile, 2.1–2.4 mm long, 0.6–0.85 mm wide in profile, obtuse to truncate, entire, mucous or

midvein exerted <0.1 mm long, firm-textured, folded about the midnerve, with a dense sericeous band of short hairs along the midnerve and along both marginal nerves, glabrous between the nerves, the sericeous bands reaching to *c.* two-thirds of the way up the lemma from the base and terminating in a tuft of erect hairs 0.5–1 mm long, glabrous beyond each hair tuft. *Palea* 1.5–2 mm long, 0.2–0.3 mm wide in profile, curved in profile, narrowly truncate apically, \pm notched, the two keels well separated, each with a narrow sericeous band extending *c.* two-thirds their length from the base, sericeous band terminating in a tuft of erect hairs, glabrous beyond each hair tuft. *Lodicules* 2, 0.15–0.25 mm long, 0.15–0.25 mm wide, fleshy, truncate. *Anthems* 3, 0.4–0.8 mm long, 0.2–0.35 mm wide, pale yellowish cream. *Caryopsis* narrowly elliptic (dorsal view), 1.1–1.4 mm long, acute apically, very finely striate, light brown, subglossy, unequally 3-angled in cross-section with acute dorsal angle; medial faces 0.5–0.6 mm wide, flat to slightly convex; ventral face 0.35–0.45 mm wide, slightly concave; embryo 40–65% the length of the caryopsis. (Figure 1)

Diagnostic characters. *Brachyachne anisocarpa* is readily distinguished from all other species in the genus by the combination of small erect stature, glabrous to scaberulous leaf sheaths and abaxial surface of blades, two (very rarely three or one) short inflorescence branches, small spikelets falling whole with enclosed floret, keeled lower glume but dorsally rounded upper glume with a raised central nerve, well separated palea keels and acute caryopses that are unequally 3-angled in cross-section.

Specimens examined. WESTERN AUSTRALIA: [locality withheld for conservation reasons], Feb. 1980, [R.]J. Petheram 573B (NT). NORTHERN TERRITORY: Granites Goldmine Lease, *c.* 1 km from Tanami Hwy on road to Ivy Camp, 29 Apr. 1999, D.E. Albrecht 8935 (NT); Cultivated Australian National Botanic Gardens nursery, 6 Mar. 2018, D.E. Albrecht 15238 (CANB, NT, PERTH) ex Northern Territory, Stuart Hwy *c.* 1.9 km N of intersection with Mary Ann Dam Road, N of Tennant Creek, 13 May 2017, D.E. Albrecht 15036 & R.W. Jobson (CANB); Stuart Hwy *c.* 25.5 km due SSE of Renner Springs roadhouse, 14 May 2017, D.E. Albrecht 15125 & R.W. Jobson (CANB); 40 km S of Tennant Creek and 4 km E of Stuart Hwy, 21 Apr. 1996, D.E. Albrecht 7504 & P.K. Latz (NT).

Distribution and habitat. *Brachyachne anisocarpa* is presently known from very few dispersed sites in the northern arid/semi-arid regions of the Northern Territory and Western Australia (Figure 2). Within the Northern Territory, collections have been made from the central Tanami between Tennant Creek and Renner Springs, and in the western Tanami near the Granites Goldmine. Only a single collection has been made from Western Australia, east of Halls Creek. Areas of suitable habitat for the species occur in the intervening areas between known sites, although they are patchy and frequently small. It is possible that the species occurs further west of Halls Creek and may extend eastward toward or into Queensland, though no collections from Queensland were located at BRI.

Brachyachne anisocarpa occurs on flat to gently undulating terrain with a distinctive stony surface layer usually with conspicuous quartz fragments (Figure 3). Soil pH in the rooting zone at one site in the central Tanami was 6.5 and at another site 7–7.5. Further study of soil chemistry may reveal elevated salinity levels as has been found at sites with a similar appearance in central Australia (Kennedy 1999). In the Northern Territory, the stony pavements supporting populations of *B. anisocarpa* occur as small islands within more widely distributed hummock grassland dominated by *Triodia longiceps*, *T. inutilis* or *T. bitextura*, with or without mallees such as *Eucalyptus normantonensis*. The vegetation on these stony pavements has low biomass/cover. Chenopods such as *Atriplex vesicaria*, *Sclerolaena cuneata*, *S. intricata* and *S. minuta* may be present, however the most frequently occurring species include *Trianthema triquetrum* s. lat., *Polycarphaea ?breviflora*, *Eriachne pulchella*, *Sporobolus australasicus*, and *S. actinocladus*. *Brachyachne convergens* may occur in the vicinity. In Western Australia, *Brachyachne anisocarpa* has been recorded growing amongst *Triodia intermedia* in a bare stony area.

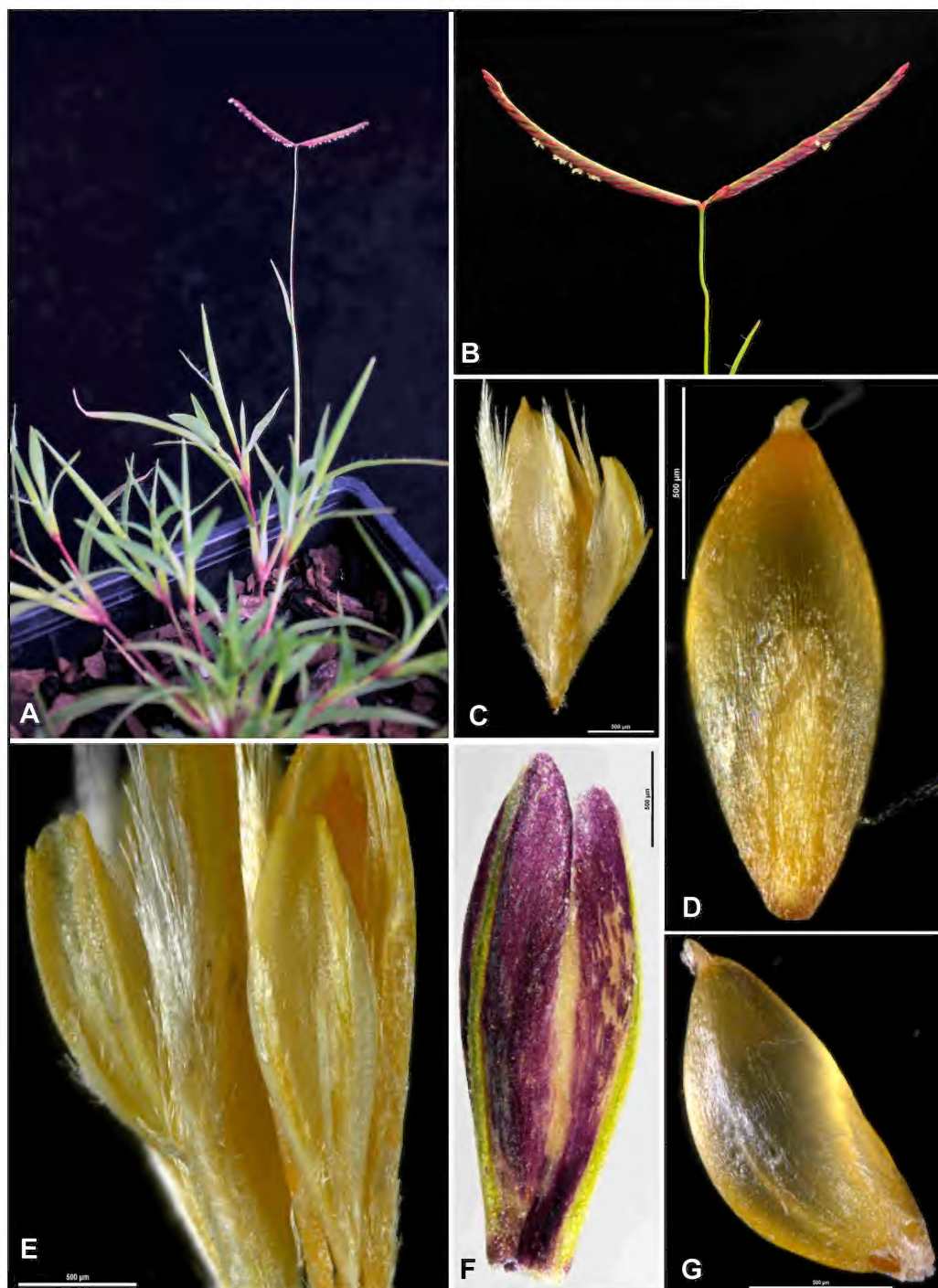


Figure 1. *Brachyachne anisocarpa*. A – habit in cultivation at ANBG; B – inflorescence; C – floret in profile; D – caryopsis dorsal view; E – florets (x2) ventral view showing well separated palea keels; F – spikelet, showing dorsally keeled lower glume (RHS) and dorsally rounded upper glume with raised central nerve (LHS); G – caryopsis oblique view showing narrower, slightly concave ventral face. A–G from D.E. Albrecht 15234; credits: M. Fagg (A–B); B. Clinton (C–G).

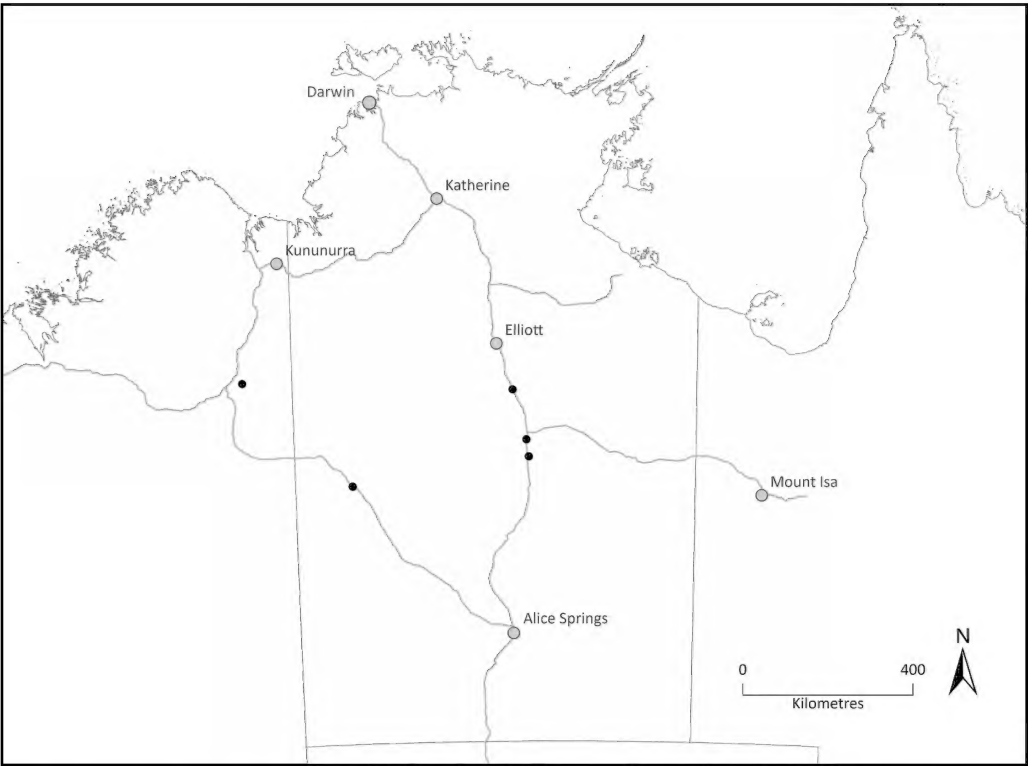


Figure 2. Distribution of *Brachyachne anisocarpa* in northern Australia based on all available specimens in Australian herbaria as of 24 May 2022. Major roads are shown.



Figure 3. Habitat at type locality.

Phenology. Germination, vegetative growth and subsequent flowering and fruiting are driven by significant rainfall events. Using Tennant Creek climatic data as indicative of the greater Tanami region, sufficient rainfall to trigger germination may occur between the months of (November–) December–February (–March). At this time of the year, the mean maximum temperature is approximately 35–38°C and mean minimum 23–25°C (Bureau of Meteorology 2022), though the maximum temperatures may drop as much as 5°C during and for a few days after significant rainfall events.

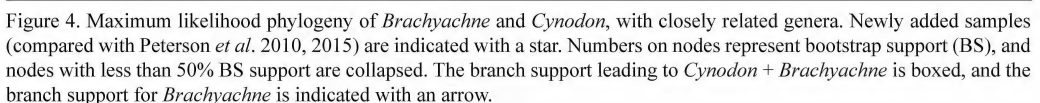
Although field-based information on growth rates is unavailable, proxy data was collected for plants grown in cultivation at the ANBG over the summer of 2017–2018. In this nursery-based trial, several seeds in a soil seedbank sample germinated in late December 2017 and the resulting seedlings were pricked out into tubes in early January 2018. These plants commenced flowering at seven weeks and began producing fully developed caryopses at 10 weeks.

Etymology. The specific epithet is derived from the Greek *an-*, not, *-iso-*, equal, *-karpos*, fruit, in reference to the unequal faces of the caryopses.

Conservation status. Due to the paucity of collections, a coding of data deficient is suggested. Given the vast tracts of country that could support the species, it is probable that further fieldwork will reveal that this taxon is neither rare nor threatened. Although known populations are highly localised, plants within a population can be locally abundant. For Western Australia, it will be listed as Priority One under Conservation Codes for Western Australian Flora (Tanya Llorens, pers. comm.).

Affinities. Based on the molecular phylogeny, *Brachyachne anisocarpa* is sister to *B. ciliaris*, and *B. prostrata* is sister to both species (Figure 4). The molecular data is congruent with morphological data, as all three species share a similar glume morphology. *Brachyachne ciliaris* most closely resembles *B. anisocarpa* on account of their similar habit and inflorescence form. However, *B. ciliaris* is readily distinguished by the presence of tubercle-based hairs on the abaxial leaf sheath and abaxial leaf blade surfaces (*cf.* glabrous in *B. anisocarpa*, except for a few hairs sometimes on the distal leaf sheath margins/sub-margins near the ligule), longer inflorescence branches ((18–)20–60 mm long, *cf.* 9–25 mm long in *B. anisocarpa*), longer glumes (3.1–4 mm long, *cf.* 2.3–3(–3.2) mm long in *B. anisocarpa*), the spikelets disarticulating above the glumes (*cf.* below the glumes in *B. anisocarpa*), the presence of a subapical transverse fringe of hairs on lemma and palea (hairs only in longitudinal bands in *B. anisocarpa*), and the obtuse obovate grain that is slightly laterally compressed and non-angular (oval) in cross-section (*cf.* acute, narrowly elliptic and unequally 3-angled in cross-section in *B. anisocarpa*). In the central Tanami north of Tennant Creek, *B. ciliaris* occurs in the vicinity of *B. anisocarpa*. However, on current knowledge, the two are not known to co-occur, the former preferring less extreme edaphic conditions (typically ironstone) and often associated with Mulga (*Acacia aneura* F.Muell. ex Benth. and allied species). This habitat distinction may be of some value in the Tanami region but it is unreliable in the broader arid region where *B. ciliaris* occurs over a greater range of habitats.

Brachyachne anisocarpa occurs within a region where *B. convergens* is the most frequently occurring species in the genus and reduced forms of the latter could possibly be confused with it. *Brachyachne convergens* is readily distinguished by its longer ((15–)20–80 mm long, *cf.* 9–25 mm long in *B. anisocarpa*) and more numerous inflorescence branches ((2–)3–4(–6), though rarely, if ever wholly 2 on a plant, *cf.* 2, rarely 1 or 3 in *B. anisocarpa*), lanceolate (*cf.* elliptic or narrowly obovate in *B. anisocarpa*) spikelets that generally disarticulate above the glumes (*cf.* below the glumes in *B. anisocarpa*), longer acute glumes ((2.7–)3.2–6.5 mm long, *cf.* 2.3–3(–3.2) mm long in *B. anisocarpa*) both of which are keeled (*cf.* only lower glume keeled in *B. anisocarpa*) and more prominently winged (wing 0.05–0.2 mm wide, *cf.* wing absent or <0.05 mm wide in *B. anisocarpa*), palea keels touching



or close together (*cf.* well separated in *B. anisocarpa*) and usually larger caryopses (1.1–)1.3–2 mm long, *cf.* 1.1–1.4 mm long in *B. anisocarpa*) that are obtuse apically, strongly laterally compressed and narrowly elliptic in cross-section (*cf.* acute apically and unequally 3-angled in cross-section in *B. anisocarpa*).

Notes. Type specimens were collected from plants raised in cultivation from a soil seed bank sample associated with D.E. Albrecht 15125 & R.W. Jobson. Cultivated plants were broader in diameter than field-gathered specimens, with more extensive branching at the lower nodes. Inflorescence branch length was also slightly longer in some cultivated plants than in field-gathered specimens, and whereas only 2-branched inflorescences had been seen in field-gathered specimens, rare 1- or 3-branched inflorescences were observed in cultivated plants.

The species is atypical in the genus in having spikelets that disarticulate below the glumes, a character state that is at odds with published descriptions of *Brachyachne s. str.* (e.g. Lazarides 1972: 41–48; Nightingale *et al.* 2005).

Although *B. anisocarpa* is known to occur in Western Australia (based on the Petheram specimen in NT) there are currently no specimens of the species in the Western Australian Herbarium (R. Barrett, pers. comm.).

Due to the difficulty of incorporating *B. anisocarpa* into the *Brachyachne* key in the *Flora of Australia* (Nightingale *et al.* 2005: 295), a revised key to species of *Brachyachne* occurring in Australia is presented below:

Key to species of *Brachyachne* in Australia

1. Lower glume strongly laterally compressed and keeled, upper glume rounded on back with a raised central nerve 2
- 1: Both glumes strongly laterally compressed and keeled 4
2. Plants prostrate and frequently branching at the nodes including those well above base; peduncle not or very shortly exceeding subtending spathe at maturity; inflorescence branches 3–5, each 4–15 mm long, usually not long-persistent **B. prostrata**
- 2: Plants erect or ascending but culms sometimes geniculate towards base, unbranched or mostly branching at lower nodes; peduncle distinctly exceeding subtending spathe at maturity; inflorescence branches 2(–4), each 9–60 mm long, long-persistent 3
3. Leaf sheaths and abaxial surface of blades villous with tubercle-based hairs; inflorescence branches (18–)20–60 mm long; florets falling with or after the upper glume, lower glume at least briefly persistent; glumes 3.1–4 mm long; lemmas with a subapical transverse fringe of hairs in addition to hairs on keel and nerves; caryopsis obtuse apically, more or less oval-shaped in cross-section **B. ciliaris**
- 3: Leaf sheaths and abaxial surface of blades (excluding margins and collar) glabrous to scaberulous; inflorescence branches 9–25 mm long; whole spikelet falling as a unit; glumes 2.3–3(–3.2) mm long; lemmas lacking a subapical transverse fringe; caryopsis acute apically and unequally 3-angled in cross-section **B. anisocarpa**
4. Spikelets asymmetrically elliptic or obovate; lemmas 1.2–1.8 mm long, with hairs on keel and margins and also in a longitudinal (sometimes very sparse) band between keel and margins; palea keels well separated; caryopsis 0.8–1 mm long, not or very weakly compressed (broadly elliptic to circular in cross-section) **B. tenella**

- 4: Spikelets lanceolate to almost elliptic; lemmas 1.6–2.8 mm long, with hairs on keel and margins but glabrous between; palea keels touching or close together (c. 0.1 mm apart); caryopsis 1–2 mm long, strongly compressed (narrowly elliptic in cross-section) **5**
5. Inflorescence branch axes 0.4–0.6 mm wide; glumes 2–3 mm long, wingless or with a narrow wing rarely exceeding 0.05 mm wide; lemmas 1.6–2.1 mm long, less than 1 mm shorter than the longest glume; caryopsis 1–1.3 mm long **B. ambigua**
- 5: Inflorescence branch axes (0.5–)0.6–1.1 mm wide; glumes (2.7–)3.2–6.5 mm long, with a wing 0.05–0.2 mm wide; lemmas (1.7–)2.2–2.8 mm long, at least 1 mm shorter than the longest glume; caryopsis (1.1–)1.3–2 mm long **B. convergens**

Notes on other *Brachyachne* species

Brachyachne ambigua

Limited molecular and morphological data suggest *B. ambigua* is sister to *B. convergens*. Further detailed study is required to determine whether *B. ambigua* should be recognised or included within *B. convergens*. They are extremely similar in terms of ITS sequences, only differing at two sites. The type specimen of *B. ambigua* is poor and further collections from Asia and Australia are required, including those that focus on population variability. *Brachyachne ambigua* is included in the key presented herein but due to limited available material the features used to distinguish it from *B. convergens* are tentative and may be unreliable. Specimens that blur the distinction between the two taxa include some from the Humpty Doo area in the Northern Territory. A sample currently assigned to *B. convergens* from the Pilbara region (*M.E. Trudgen* 11682 & *S. Maley*) has atypically small glumes, lemmas and caryopses that are well within the range of *B. ambigua*. The glume, lemma and caryopsis measurements for this specimen are included as extreme lower values (in parentheses) in the *B. convergens* lead of couplet 5 in the key above.

The type of *B. ambigua* was collected in East Java, and the species has also been recorded from Lesser Sunda Island, New Guinea, the Northern Territory and north-eastern Western Australia (Nightingale *et al.* 2005). The occurrence in New Guinea requires further checking as CANB specimens previously determined as this species have been redetermined to *B. tenella* (see below). If *B. ambigua* is maintained as distinct from *B. convergens*, then the former also occurs in Queensland based on the following specimen: 1.2 km south of Princess Charlotte Bay coastline, 7 Apr 1992, *V.J. Neldner* 3725 & *J.R. Clarkson* (BRI).

Brachyachne tenella

Although *B. tenella* is reported to be endemic to Australia (Nightingale *et al.* 2005), the following three specimens from Papua New Guinea have been redetermined by the principal author from *B. ambigua* to *B. tenella*: Kajabit mission, 25 July 1939, *M.S. Clemens* 10473 (CANB); Near Kwikila, Rigo Sub district, 8 July 1962, *R. Pullen* 3234 (CANB); Tavai Creek Area, c. 43 miles SE of Port Moresby, 7 May 1967; *R. Pullen* 6937 (CANB).

Notes on the generic status of *Brachyachne*

Phylogenies presented in Peterson *et al.* (2010) and Peterson *et al.* (2015) showed the group of *Brachyachne* species occurring in Australia, Melanesia and Indonesia (i.e. *Brachyachne s. str.*,

hereafter *Brachyachne*) as nested, or partially nested within *Cynodon* (*n.b.* the African species of *Brachyachne* included in these phylogenies are now recognised as species of *Micrachne* and will not be considered further). Peterson *et al.* (2010) produced three phylogenies based on ITS1 & 2 (their Figure 1), six plastid loci (their Figure 2), and a combined analysis of ITS + plastid (their Figure 3), that included two samples of *Brachyachne* and 10 samples of *Cynodon*. In each phylogeny, the clade including both genera was well-supported (bootstrap support from 89 to 100; posterior probability of 1.0), but the relative position of the *Brachyachne* species to the *Cynodon* species differed. In their ITS phylogeny, the two *Brachyachne* samples were not monophyletic, with *B. tenella* sister to *Cynodon* (with *B. convergens* nested in *Cynodon* with moderate support). Their plastid phylogeny had the two *Brachyachne* samples as sister (74% BS, 1.00 PP) but also had *C. maritimus* Kunth as sister to *Brachyachne* rather than within the rest of *Cynodon* (though with no support). Their combined analysis had another topology, with *Brachyachne* + *C. maritimus* as sister to *Cynodon*, though again with no support. No taxonomic decisions were made for *Brachyachne* based on this tree.

The Peterson *et al.* (2015) phylogeny had denser taxon sampling of *Cynodon* (46 samples) and *Brachyachne* (five samples), and used four plastid regions and ITS1 & 2, but only performed a combined analysis (and thus does not present any potential conflict in the different loci sets relating to *Brachyachne*). The clade including both genera was again well-supported (100% BS, 1.00 PP). The five *Brachyachne* samples formed a poorly supported group (no BS, 0.68 PP). However, *Cynodon maritimus* (now represented by two samples, albeit one sample only had sequence for one plastid locus, *rpl32-trnL*, i.e. missing ~80% data) was resolved as sister to all remaining *Cynodon* species + *Brachyachne* (i.e. no longer sister to just *Brachyachne*), although no support values were shown along this part of the tree, indicating that this topology was not well-supported. Based on this poorly supported topology, Peterson *et al.* (2015) suggested that *Brachyachne* arose within *Cynodon*, and the morphological characters that were used to originally separate the genera (glumes longer than the floret and lemmas that are long-hairy on the veins or all over in *Brachyachne*, versus at least one glume shorter than the floret and lemmas that are hairy or not only along the midvein in *Cynodon*) were not synapomorphies. Where required, new combinations for species of *Brachyachne* were made in *Cynodon*. To date the proposal to synonymise *Brachyachne* under *Cynodon* has not received universal acceptance within Australia.

The phylogeny presented in this paper (Figure 4) has the same topology as the Peterson *et al.* (2015) phylogeny, except we have collapsed any branch with less than 50% BS support. Based on this topology, *Brachyachne* is nested within *Cynodon* due to a sample of *C. maritimus*. This species is treated as a synonym of *C. dactylon* (L.) Pers. (Clayton *et al.* 2022), but according to the various phylogenetic analyses including this sample, it is distinct from any samples of *C. dactylon*. Resolving the taxonomic status of *C. maritimus* is important, not only for understanding its position in the phylogeny, but also for understanding the generic relationships between *Cynodon* and *Brachyachne*. Regardless, with the data available currently and considering only well-supported nodes (>75% BS), *Cynodon* and *Brachyachne* can only be resolved as part of the same polytomy.

Cynodon and *Brachyachne* are clearly closely related. However, given that the two genera are readily separated morphologically, their native ranges are geographically separated, and the relationship between them is poorly resolved on available molecular data, we feel that it is premature to accept the new classification outlined in Peterson *et al.* (2015) and have chosen to name this new taxon as a species of *Brachyachne*. Phylogenomics, especially target capture methods, with increased sampling of species and genetic data will be vital to clarify the status of *Brachyachne* relative to an expanded *Cynodon* that includes *Brachyachne*.

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References

- Bureau of Meteorology (2022). *Monthly climate statistics, Tennant Creek Airport (site 015135)*. Commonwealth of Australia. http://www.bom.gov.au/climate/averages/tables/cw_015135.shtml [accessed 24 May 2022].
- Chen, S., Yao, H., Han, J., Liu, C., Song, J., Shi, L., Zhu, Y., Ma, X., Gao, T., Pang, X., Luo, K., Li, Y., Li, X., Jia, X., Lin, Y. & Leon, C. (2010). Validation of the ITS2 region as a novel DNA barcode for identifying medicinal plant species. *PLoS ONE* 5(1): e8613. <https://doi.org/10.1371/JOURNAL.PONE.0008613>
- Clayton, W.D., Govaerts, R., Harman, K.T., Williamson, H. & Vorontsova, M. (2022). World Checklist of Poaceae. Facilitated by the Royal Botanic Gardens, Kew. Published on the Internet; <http://wccsp.science.kew.org/> [accessed 4 Aug 2022]
- Kennedy, P.A. (1999). *Why are there white spots in the west? Community ecology of some vegetation patches in the West MacDonnell National Park*. Unpublished BSc (honours) thesis. School of Biological and Environmental Sciences, Northern Territory University.
- Lazarides, M. (1972). A revision of Australian Chloridoideae (Gramineae). *Australian Journal of Botany Supplementary Series* 2(5): 1–51.
- Nightingale, M.E., Lazarides, M. & Weiller, C.M. (2005). *Brachyachne*. In: Mallett, K. (ed.) *Flora of Australia* Vol. 44B. pp. 294–300. (Australian Biological Resources Study: Canberra.)
- Peterson, P.M., Romaschenko, K. & Johnson, G. (2010). A classification of the Chloridoideae (Poaceae) based on multi-gene phylogenetics trees. *Molecular Phylogenetics and Evolution* 55: 580–598.
- Peterson, P.M., Romaschenko, K. & Arrieta, Y.H. (2015). A molecular phylogeny and classification of the Eleusininae with a new genus, *Micrachne* (Poaceae: Chloridoideae: Cynodonteae). *Taxon* 64(3): 445–467.
- Petheram, R.J. & Kok, B. (1983). *Plants of the Kimberley region of Western Australia*. (University of Western Australia Press: Nedlands.)
- Stamatakis, A. (2014) RAxML version 8: A tool for phylogenetic analysis and post-analysis of large phylogenies. *Bioinformatics* 30: 1312–1313.

A taxonomic review of the *Styphelia tamminensis* subgroup (Ericaceae: Epacridoideae: Styphelieae)

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Abstract

Hislop, M. & Nguyen, H.K., A taxonomic review of the *Styphelia tamminensis* subgroup (Ericaceae: Epacridoideae: Styphelieae). *Nuytsia* 33: 275–320 (2022). Within the heterogeneous *Styphelia* Sm. Group X, a distinctive Western Australian subgroup is recognised based on morphological and molecular data. A morphological synopsis of the subgroup is provided and the following 13 new species are described and illustrated: *S. annulata* Hislop, *S. bracteolosa* Hislop, *S. echinulata* Hislop, *S. exilis* Hislop, *S. hyalina* Hislop, *S. incerta* Hislop, *S. pallens* Hislop, *S. papillosa* Hislop, *S. platyneura* Hislop, *S. recurva* Hislop, *S. roseola* Hislop, *S. scabrella* Hislop and *S. subglauca* Hislop. Nine of the novel species are conservation-listed. A key to all 19 members of the subgroup is included.

Introduction

Of the 12 phylogenetic groups resolved in *Styphelia* Sm. by Puente-Lelièvre *et al.* (2016), nine occur in Western Australia. Most species of Western Australian *Styphelia* have been placed in one of these nine groups, either through their placement in the published phylogeny or by extrapolation of critical morphological features. A recent short paper (Hislop 2021) provided an interim key to the infrageneric groups in Western Australia together with lists of their included taxa, both the formally described and phrase-named. The species described below have all previously been recognised by phrase names in *Leucopogon* R.Br. and belong to Group X. This is the most heterogeneous of the groups and likely also the most speciose; it is well represented in both eastern and western Australia. Despite the morphological diversity across the group, it forms a well-supported clade in the phylogeny (Puente-Lelièvre *et al.* 2016). It is significant, however, that in comparison with the other large groups occurring in Western Australia the sampling density in Group X was lower, and some critical branch values were very weak, meaning that our understanding of infra-group relationships is relatively less well developed. Further molecular research within Group X is therefore desirable before a formal infrageneric classification is finalised.

Within the western members of the group several morphological elements are evident; these mostly correspond to well-supported terminal subclades within the phylogenetic tree. The species described in this paper belong to a particularly distinctive subclade that is informally referred to herein as the *S. tamminensis* subgroup.

Methods

This study was based on an examination of dried specimens housed at the Western Australian Herbarium (PERTH), together with field observations of all members of the *S. tamminensis* subgroup.

Foliar measurements and observations were taken from dried specimens in natural posture. Care was taken to confine observations to mature leaves. Leaf lamina length is inclusive of the mucro. A separate measurement for the mucro is also given. Inflorescence length was measured from the point of attachment in the axil to the tip of the bud-rudiment, or to the flower base in those species where the bud-rudiment is lacking. Floral measurements were taken from rehydrated flowers in natural posture except for the corolla lobes, which were uncurled to their fullest length before measuring. Observations of the floral indumentum were taken from dried material at $\times 50$ magnification. Fruit length is inclusive of a gynophore, if present.

Relative to the ovarian locules of other *Styphelieae*, those of the *S. tamminensis* subgroup are very narrow and obscure. The best method by which to observe these is to make a transverse section with a very sharp scalpel close to the ovary base of rehydrated flowers and use a magnification of at least $\times 50$.

Distribution maps are available on *Florabase* (Western Australian Herbarium 1998–). Bioregions follow the *Interim Biogeographic Regionalisation for Australia* (IBRA) v. 7 (Department of Climate Change, Energy, the Environment and Water 2021).

Taxonomy of the *Styphelia tamminensis* subgroup

The following seven taxa from the *S. tamminensis* subgroup form a well-supported subclade (Puente-Lelièvre *et al.* 2016): *Leucopogon tamminensis* var. *australis* E.Pritz. (now *S. decussata* Hislop, Crayn & Puente-Lel., see Crayn *et al.* 2020), *L.* sp. Warradarge (now *S. williamsiorum* Hislop & Puente-Lel., see Hislop & Puente-Lelièvre 2017), *L.* sp. Great Southern (now *S. annulata* Hislop, described below), *L.* sp. Wandering (now *S. recurva* Hislop, described below), *L.* sp. Gunapin (now *S. bracteolosa* Hislop, described below), *L.* sp. Tathra (now *S. pallens* Hislop, described below), and *L.* sp. Yandanooka (now *S. hyalina* Hislop, described below). There are another twelve species that can be placed in this subgroup by morphological extrapolation, four of which were published in the nineteenth or early twentieth century, namely *S. crassifolia* (Sond.) F.Muell., *S. cymbiformis* (DC.) F.Muell., *S. pogonocalyx* (Benth.) F.Muell. and *S. tamminensis* (E.Pritz.) Sleumer. The remaining eight are described below as new species: *S. echinulata* Hislop, *S. exilis* Hislop, *S. incerta* Hislop, *S. papillosa* Hislop, *S. platyneura* Hislop, *S. roseola* Hislop, *S. scabrella* Hislop and *S. subglaucous* Hislop.

Morphological synopsis

Leaves opposite or helically arranged; apex usually mucronate, the mucro pungent, less often sub-pungent or non-pungent, occasionally absent; lamina usually adaxially concave, rarely convex or plano-convex; abaxial surface flat or variously grooved between the veins, glabrous or variously hairy. *Inflorescence* arising from the axils of regular, mature leaves, 1–7-flowered, flowers sessile; axis erect, either terminating in a bud-rudiment (all species with spiral phyllotaxis) or bud rudiment absent (most species with opposite phyllotaxis). *Bracteoles* not striate, keeled (species with helical phyllotaxis) or not (opposite phyllotaxis). *Sepals* not striate, with usually obscure venation (only the mid-vein evident), shorter than the corolla tube in most species, \pm equal to or longer than the tube in a few. *Corolla* white, pink, red, purple, pale yellow or cream. *Corolla tube* internal surface variously

hairy at least in the upper half, external surface glabrous or hairy. *Corolla lobes* spreading from close to the base in most species (erect for about a third of their length in *S. recurva*); outer surface usually glabrous, very occasionally sparsely hairy; inner surface densely hairy with \pm terete, almost completely smooth and usually \pm straight, hairs. *Filaments* terete, very short, to 0.2 mm long, attached at or very close to the anther apices, adnate to corolla tube just below the sinuses or in some species well down within the tube. *Anthers* wholly included within the corolla tube or occasionally very shortly exserted by up to 1/4 of length. *Ovary* glabrous or variously hairy, 3-locular (very rarely 4-locular), pale green, yellow-green or straw-coloured. *Nectary* partite. *Style* glabrous or papillose, always included within the corolla tube and usually <0.4 mm long (1.4–1.8 mm in *S. incerta*), usually smoothly attenuated from (and with the base not clearly differentiated from) an acute ovary apex (abruptly differentiated from an obtuse ovary apex in *S. exilis* and *S. incerta*). *Drupe* \pm dry (mesocarp not, or poorly developed), often with a well-defined gynophore, cylindrical, very narrowly ovoid, very narrowly obovoid or \pm fusiform, with prominent, slightly raised, pale ribs.

Notes. A combination of distinctive morphological features makes the recognition of the *S. tamminensis* subgroup relatively straightforward, in most cases. All members, with the exception of *S. incerta*, key out at the first lead of couplet 18 in the recently published interim key to species groups (Hislop 2021).

The most diagnostic characters relate to the gynoecium. All species in the subgroup have a 3-locular ovary, with the locules narrow and obscure. Other western members of Group X have a 5-locular ovary except for *Leucopogon* sp. outer wheatbelt (M. Hislop 30), which has a consistently 3-locular ovary, and *L.* sp. Mount Heywood (M.A. Burgman 1211) and *L.* sp. Lort River (M. Golding 3) in which the ovary is either 2- or 3-locular. In addition, all species in the subgroup have a style that is included within the corolla tube; in most cases it is very short and often not clearly differentiated from the acute ovary apex (Figures 1D, 7D). The posture of the corolla lobes is also important: in all but one species these spread directly from, or very close to, their base rather than being erect in the lower 1/3–2/3 before spreading, which is the most common configuration in Group X and elsewhere in *Styphelia*. Very short filaments (to 0.2 mm long) and anthers that are either included in the corolla tube or with just the tips exserted are other floral characters by which the subgroup can be recognised. In several species the filaments are inserted well below the throat of the corolla tube rather than a little below the lobe sinuses, which is the usual point of attachment. This is another very unusual feature rarely seen elsewhere in western *Styphelia*. It is noteworthy that across the entire genus, species with consistently opposite leaves are restricted to this subgroup, although a majority have a helical phyllotaxis.

The interpretation of the obscure ovarian locules in this subgroup evidently caused Bentham (1868) some problems. In his treatment of *Leucopogon cymbiformis* (actually *Styphelia annulata*, see description of that species below) he commented ‘I have had the greatest difficulty in ascertaining the structure of the ovary’ and concluded that in the ‘more than a dozen different specimens’ examined the ovaries were ‘diseased’. He was only confident of the locule count in one specimen which he recorded as ‘distinctly 2-celled, but the ovules were still imperfect’. This seems unlikely, however, as a 2-locular ovary has never been observed for any member of *S. tamminensis* subgroup.

Species of the *S. tamminensis* subgroup form part of the ‘*Gynoconus*’ segregate proposed by Powell *et al.* (1997) as one of several new generic groupings within *Leucopogon* s. lat. based on morphological data. As originally conceived, ‘*Gynoconus*’ included both eastern and western Australian taxa. Subsequent molecular research (Taaffe *et al.* 2001; Quinn *et al.* 2003) did not support the recognition of ‘*Gynoconus*’ as so constituted, but the phylogeny obtained by Puente-Lelièvre *et al.* (2016) indicates that at least the Western Australian members of that grouping are monophyletic.

Key to species of the *S. tamminensis* subgroup

Note that corolla colour refers to the tube and lobe surfaces, ignoring the always white lobe hairs.

1. Leaves opposite, decussate
 2. Fertile bracts and bracteoles with uncinat apices; bracteoles foliose, 2.6–4.2 mm long, as long as or more often longer than the sepals; inflorescence axes usually multi-flowered, 2.5–10 mm long (Darling Range; NW of York–W of Beverley) ***S. bracteolosa***
 - 2: Fertile bracts and bracteoles without uncinat apices; bracteoles not foliose, 0.7–1.6 mm long, shorter than the sepals; inflorescence axes reduced, usually 1- or very rarely 2-flowered and 0.2–0.8 mm long, up to 4-flowered and 1.5–3.5 mm long in *S. exilis*
 3. Inflorescence axes 1.5–3.5 mm long, 1–4-flowered, terminating in a bud-rudiment; leaves to 1 mm wide, leaf apices non-mucronate, narrowly obtuse; external corolla tubes glabrous; ovary apex obtuse, style distinct and abruptly differentiated from ovary (Manypeaks–Wellstead) ***S. exilis***
 - 3: Inflorescence axes 0.2–0.8 mm long, 1- or very rarely 2-flowered, apparently terminating in a flower or bract-like point rather than a bud-rudiment; wider leaves >1 mm wide or if less then apex clearly mucronate; ovary apex acute, style not or scarcely differentiated from ovary
 4. Corolla tube externally glabrous
 5. Sepals glabrous abaxially, margins glabrous; filaments adnate to tube just below sinuses; ovary glabrous (S of Mingenew–W of Three Springs) ***S. hyalina***
 - 5: Sepals hairy abaxially, occasionally the hairs very sparse, margins ciliolate or lacinate at least in the distal half or very occasionally \pm glabrous; filaments adnate to tube well below sinuses (i.e. $2/3$ – $3/4$ the length of the tube above the base); ovary hairy, especially towards the base (New Norcia–Yerecoin–Bindoon–ulimar State Forest) ***S. roseola***
 - 4: Corolla tube variously hairy externally
 6. Filaments adnate to tube just below the sinuses; sepals hairy adaxially at apex and/or base (usually both), apices acute to acuminate, often filiform, darkly pigmented and not recurved (Corrigin–Boxwood Hill–Munglinup) ***S. decussata***
 - 6: Filaments adnate to tube well below the sinus (i.e. $2/3$ – $3/4$ the length of the tube above the base); sepals glabrous adaxially, apices obtuse or if acute (*S. williamsiorum*) then recurved and not darkly pigmented
 7. Corolla uniformly pink; sepal margins broadly hyaline; filaments attached to anthers just below the anther apex (New Norcia–Yerecoin–Bindoon–Julimar State Forest) ***S. roseola***
 - 7: Corolla uniformly purple or pale yellow to cream, sometimes partially flushed red; sepal margins not noticeably hyaline; filaments attached to anthers $1/2$ – $3/4$ above anther base
 8. Corolla uniformly purple; leaves flat to shallowly grooved abaxially between the veins; sepals glabrous abaxially or very occasionally with a few antrorse hairs, apices obtuse to acute and usually recurved (South Eneabba Nature Reserve–Badgingarra–Alexander Morrison National Park) ***S. williamsiorum***
 - 8: Corolla pale yellow to cream, sometimes partially flushed red; leaves moderately to deeply grooved abaxially between the veins; sepals with spreading hairs abaxially, apices obtuse or subacute and not recurved (E & NE of Eneabba) ***S. pallens***

1: Leaves helically arranged

- 9:** Ovary hairy in some part, never papillose; sepals with conspicuous, thickened, green apices
- 10:** Ovary with a well-defined basal ring of hairs, glabrous above at flowering; leaves 1.4–6.0 mm long; corolla tube 2.5–3.8 mm long; corolla lobes 1.3–1.7 mm long (Widespread: Muchea–Bolgart–Dowerin southwards to SW of Mt Barker–Ongerup) ***S. annulata***
- 10:** Ovary shortly hairy in the upper 1/3–2/3, without a basal hair ring; leaves 0.8–2.3 mm long; corolla tube 1.8–2.5 mm long; corolla lobes 0.8–1.2 mm long (Bruce Rock–Wogarl–Kulin–Varley) ***S. scabrella***
- 9:** Ovary glabrous throughout, sometimes papillose; sepals lacking conspicuous, thickened, green apices (except for *S. scabrella*)
- 11:** Leaf tip without a clearly defined mucro, not pungent (rarely with a short mucro to 0.2 mm long in *S. crassifolia* and *S. cymbiformis*)
- 12:** Leaves obovate to depressed-obovate, ovate to depressed-ovate or narrowly ovate, or broadly elliptic to transversely elliptic; longest leaves <2.5 mm long
- 13:** Style 1.4–1.8 mm long; filaments adnate to tube 1/2–2/3 the length of the tube above the base; longitudinal leaf axis always very strongly recurved, the leaf tip acute and usually pungent or sub-pungent (S of Hyden–SW of Lake King) ***S. incerta***
- 13:** Style 0.1–0.5 mm long; filaments usually adnate to tube just below the sinuses, but if lower always at least 3/4 the length of the tube above the base; longitudinal leaf axis various but if recurved, the leaf tip obtuse to subacute and not pungent or sub-pungent
- 14:** Leaves ovate or narrowly ovate, acute, usually scabrous abaxially; sepals usually ± scabrous (sometimes glabrous), with conspicuous, thickened, green apices (Bruce Rock–Wogarl–Kulin–Varley)..... ***S. scabrella***
- 14:** Leaves ovate to depressed ovate or obovate to depressed obovate, obtuse to subacute or occasionally acute, never scabrous; sepals never scabrous, without thickened, green apices
- 15:** Leaves 1.3–2.0 mm long, 1.0–1.6 mm wide, obovate to ovate or broadly so, usually distinctly longer than wide; abaxial surface with a very prominent midvein, deeply and openly grooved between veins, often with short, stiff hairs on the veins; sepals shortly hairy, at least in the upper half; bracteoles shortly hairy, at least in the upper half, 1.3–1.7 mm long, 1.0–1.2 mm wide, ovate (Forrestania–Frank Hann National Park) ***S. platyneura***
- 15:** Leaves 1.2–2.0 mm long, 1.2–2.0 mm wide, broadly ovate or depressed-ovate to broadly obovate or depressed-obovate, frequently wider than long; abaxial surface with a less prominent midvein, more shallowly grooved between the always glabrous veins; sepals glabrous; bracteoles glabrous, 1.0–1.3(1.5) mm long, 0.8–1.2 mm wide, broadly ovate or ± orbicular (Merredin–E of Hyden)..... ***S. subglauca***
- 12:** Leaves narrowly obovate to narrowly elliptic, rarely narrowly ovate; longest leaves at least 3 mm long
- 16:** Sepal apices obtuse, appressed to corolla tube; external corolla glabrous; ovary papillose (Porongurup Range–South Stirling with apparent outliers at Albany & Waychinicup)..... ***S. cymbiformis***
- 16:** Sepal apices acute, subacute or occasionally obtuse, recurved or ± spreading on some or all flowers; corolla tube and often lobes variously hairy externally (rarely ± glabrous throughout); ovary not papillose (apparently disjunct: Fitzgerald River

- National Park and Cape Riche area, with outliers at Chillinup & N of Cheyne Beach)..... **S. crassifolia**
- 11:** Leaf tip with a well-defined, pungent or occasionally sub-pungent mucro 0.2–1.0 mm long
- 17:** Abaxial leaf surfaces deeply and very narrowly grooved between the veins (the bottom of the grooves not visible), with very short hairs present in the grooves, and either glabrous or with very sparse, longer hairs outside of the grooves
- 18:** Longitudinal leaf axes strongly recurved; filaments adnate to the corolla tube just below the sinuses; anthers partially exerted from the corolla tube, by 1/8–1/4 of their length (Bonnie Rock–Diemals)..... **S. echinulata**
- 18:** Longitudinal leaf axes markedly incurved; filaments adnate to the corolla tube well below the sinuses; anthers fully included within the corolla tube (disjunct: Marchagee–Watheroo; Wongan Hills area; Tammin area)..... **S. tamminensis**
- 17:** Abaxial leaf surfaces variously grooved between the veins, from shallow, open grooves to deeper, narrow grooves, but if the latter then the bottom of the grooves visible, hairs absent or present but if hairy within the grooves then with hairs of similar length and density across the surface
- 19:** Longitudinal leaf axis strongly recurved throughout; style 1.4–1.8 mm long, the base abruptly differentiated from the obtuse ovary apex (S of Hyden–SW of Lake King)..... **S. incerta**
- 19:** Longitudinal leaf axis gently incurved to gently recurved; style 0.4 mm long, the base smoothly attenuated from the acute ovary apex
- 20:** Longest leaves <2.5 mm long; leaves usually scabrous abaxially; sepals usually ± scabrous (sometimes glabrous), with conspicuous, thickened, green apices (Bruce Rock–Wogarl–Kulin–Varley)..... **S. scabrella**
- 20:** Longest leaves >4 mm long; leaves glabrous or hairy but not scabrous; sepals glabrous or hairy but not scabrous, without thickened, green apices
- 21:** Sepals acuminate, the apices usually recurved, occasionally almost straight but if so then not appressed to corolla tube (W of York–Narrogin district)..... **S. recurva**
- 21:** Sepals obtuse or occasionally subacute, the apices appressed to corolla tube
- 22:** Style clearly differentiated from ovary apex, 0.3–0.4 mm long; filaments adnate to tube just below sinuses; anther tips slightly exerted from corolla tube, easily visible in the throat (Stirling Range, an old record from Mt Many Peaks)..... **S. pogonocalyx**
- 22:** Style poorly differentiated from ovary apex, 0.1–0.2 mm long; filaments adnate to tube well below sinuses (± 3/4 the length of the tube above the base); anthers held well within the tube, not visible in the throat (NE of Wickepin–Woodanilling–Tarin Rock)..... **S. papillosa**

Species of the *S. tamminensis* subgroup

Styphelia annulata Hislop, *sp. nov.*

Typus: Sounness Farm (Paper Collar Grazing Co., East Block), near Stirling Range National Park, Western Australia, 31 October 1986, *R.S. Cowan* A-586 (*holo:* PERTH 04442164; *iso:* CANB, CNS, K, MEL).

Leucopogon sp. Great Southern (R.S. Cowan A 586), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 17 June 2022].

[*Leucopogon cymbiformis* auct. non A.Cunn. ex DC.: G. Bentham, *Fl. Austral.* 4: 200 (1868); W.E. Blackall & B.J. Grieve, *How to Know W. Austral. Wildfl.* IIIB: 332; 337 (1981); J.R. Wheeler in N.G. Marchant *et al.*, *Fl. Perth Region*: 185 (1987); G. Paczkowska & A.R. Chapman, *West. Aust. Fl.: Descr. Cat.*: 237 (2000).]

Low, usually rather compact *shrub*, mostly <40 cm high and 60 cm wide, occasionally to 70 cm high, multi-stemmed from close to base of plant but single-stemmed at ground level, with a fire-sensitive rootstock. Young *branchlets* with a sparse to moderately dense indumentum of straight or decurved hairs to c. 0.2 mm long, occasionally \pm glabrous. *Leaves* helically arranged, steeply antrorse to antrorse-appressed; apex long-mucronate, pungent, the mucro straight to slightly inflexed, 0.2–0.6 mm long; base attenuate to cuneate; petiole 0.2–0.5 mm long, glabrous or with a few marginal hairs; lamina narrowly ovate or ovate, 1.4–6.0 mm long, 0.5–1.5 mm wide, \pm concolorous, concave adaxially, longitudinal axis straight or gently recurved in the lower half and becoming incurved in the upper half or incurved throughout; adaxial surface not or very slightly shiny, glabrous or sparsely hairy mostly in the lower half, venation not evident; abaxial surface shiny, glabrous or sparsely and shortly hairy, with 5–7 pale, primary veins, flat or very shallowly grooved between the veins; margins \pm glabrous or with coarse, antrorse hairs <0.05 mm long. *Inflorescence* axillary, erect, usually grouped together in a contracted confluence; axis 2.2–5.5(7.5) mm long, (1)2–5(7)-flowered, usually with moderately dense to dense indumentum, occasionally \pm glabrous, compressed below the lowest fertile bract, angular above, terminating in a bud-rudiment; flowers erect, sessile. *Fertile bracts* narrowly ovate to ovate, 1.2–3.0(4.0) mm long, 0.7–1.0 mm wide, subtended by 3 sterile bracts, the basal 2 opposite. *Bracteoles* narrowly ovate or ovate, 1.4–3.2 mm long, 0.6–1.0 mm wide, keeled, acute, mucronate; abaxial surface glabrous or sometimes slightly scabrous; margins glabrous. *Sepals* narrowly ovate, 2.3–3.2(3.5) mm long, 0.7–1.0 mm wide, acute and often mucronate; abaxial surface glabrous or sometimes slightly scabrous, straw-coloured or yellow-green, sometimes with pink tinges in the lower half, with conspicuous, thickened, green apices, only the mid-vein evident; adaxial surface glabrous apart from a zone of sparse hairs towards the apex; margins with coarse, antrorse hairs <0.05 mm long or glabrous. *Corolla tube* white, narrowly ellipsoid, narrowly ovoid, or occasionally \pm cylindrical, longer than or rarely \pm equal to the sepals, 2.5–3.8 mm long, 0.8–1.2(1.5) mm wide, glabrous externally, internal surface with an apical band of hairs (often rather sparse) projecting into the tube, the remainder glabrous. *Corolla lobes* white, often flushed pink or pink-purple towards their apices, shorter than the tube, 1.3–1.7 mm long, 0.5–0.6 mm wide at base, spreading from the base and recurved, glabrous externally, internal surface with a dense, white indumentum of terete, usually \pm straight and essentially unornamented hairs. *Anthers* fully included within the corolla tube, 0.8–1.5 mm long, apex rounded to scarcely emarginate. *Filaments* terete, 0.1–0.2 mm long, attached to the anther at least 7/8 above base, adnate to tube a little or sometimes distinctly below the sinuses. *Nectary* partite, the scales 0.3–0.5 mm long, 0.2–0.3 mm wide, glabrous. *Ovary* narrowly or very narrowly ovoid, 1.2–1.7 mm long, 0.3–0.4 mm wide, with a basal ring of straight, antrorse hairs, glabrous above (at flowering), 3-locular, straw-coloured or yellow-green (very occasionally mid-green). *Style* scarcely differentiated from ovary apex in either flower or fruit, 0.2–0.3 mm long, slightly scabrous, included within the corolla tube; stigma expanded. *Fruit* \pm fusiform, usually curved, 3.2–4.2 mm long (inclusive of gynophore), 0.8–1.0 mm wide, much longer than the sepals, circular in section, with a well-defined gynophore; surface rather sparsely hairy in the lower 1/2–2/3, with a \pm spreading indumentum of 0.2–0.3 mm long hairs, \pm dry, smooth (mesocarp poorly developed), with pale, longitudinal ribs; apex acute, tapering smoothly to the base of the persistent style. (Figure 1)

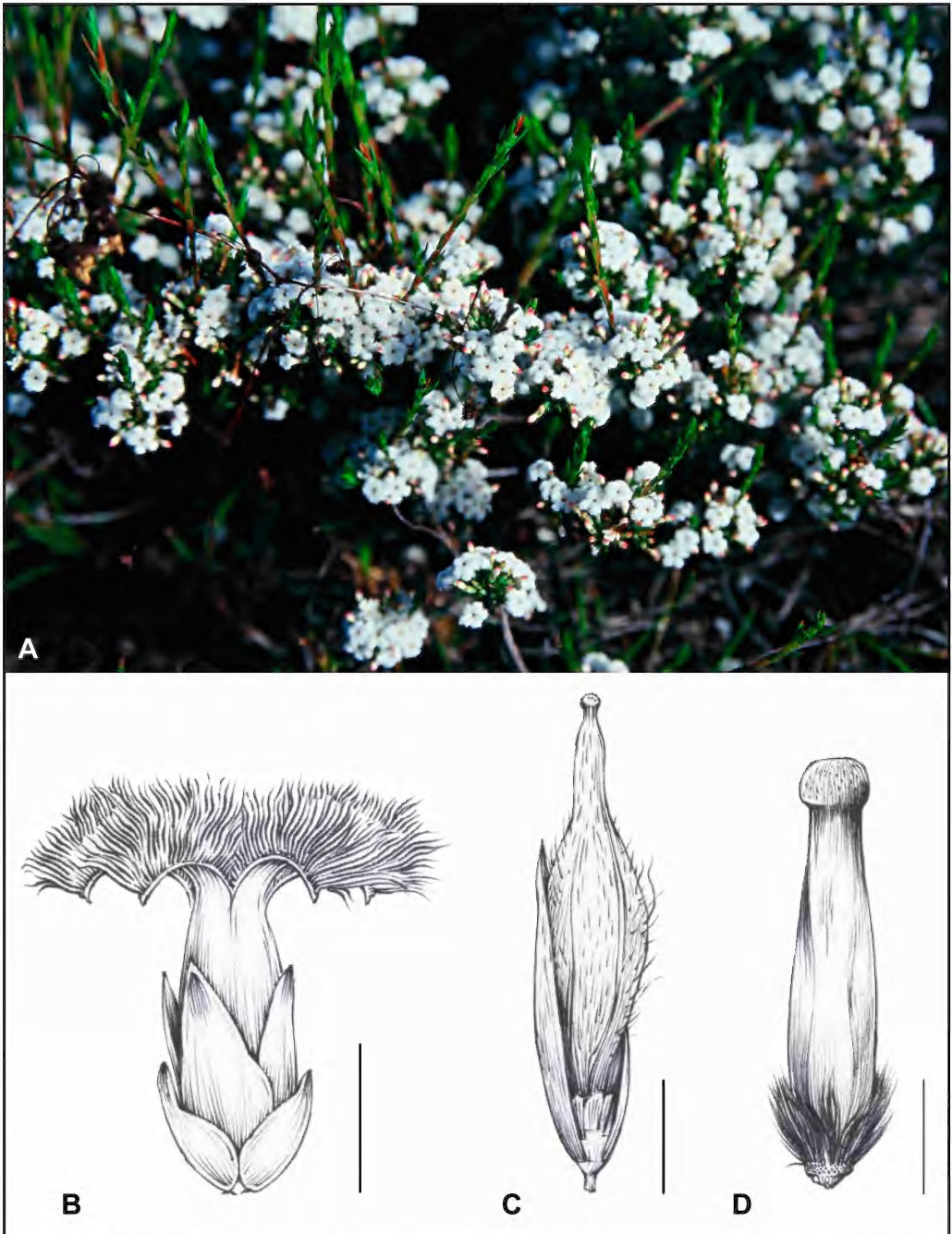


Figure 1. *Styphelia annulata*. A – flowering plant *in situ*; B – flower, external view; C – fruit, with 3 sepals removed; D – ovary at flowering. Scale bars B = 2 mm; C = 1 mm; D = 0.5 mm. Vouchers M. Hislop 2848 (A), R.S. Cowan A-586 (B), R.J. Cranfield 14419 (C, D). Photograph by Michael Hislop. Drawings by Hung Ky Nguyen.

Diagnostic characters. Within the *S. tamminensis* subgroup distinguished by the following character combination: leaves helically arranged, narrowly ovate or ovate, with the longitudinal axes straight or gently recurved in the lower half and becoming incurved in the upper half or incurved throughout; abaxial leaf surfaces not grooved or very shallowly grooved between the veins, glabrous or sparsely and shortly hairy; adaxial leaf surfaces glabrous or sparsely hairy mostly in the lower half; leaf apex long-mucronate, pungent; inflorescences (1)2–5(7)-flowered, usually grouped together in a contracted conflorescence; sepals acute and often mucronate, with well-demarcated green apices; anthers fully included within the corolla tube; filaments attached to anther at least 7/8 above base, adnate to tube a little or sometimes distinctly below the sinuses; ovary with basal ring of hairs, otherwise glabrous; style scarcely differentiated from the ovary apex in flower or fruit; fruit \pm dry, \pm fusiform, usually curved with an acute apex, sparsely hairy in the lower 1/2–2/3 with spreading hairs.

Other specimens examined. WESTERN AUSTRALIA: 2.2 km N along Dilling Railway Rd from junction with Dilling Rd, Corrigin, 6 Oct. 1997, *E.A. Brown* EAB 97/210 & *G. Taaffe* (NSW, NY, PERTH, UNSW *n.v.*); unmade road running E to Tarin Rock Nature Reserve from Bladendale Rd, 7.95 km S of Tarin Rock Rd, 7 Dec. 2005, *A. Coates* 5047 (NSW, PERTH); Crown Reserve 14531, Cunderdin Cemetery, Cemetery Rd in remnant E of cemetery, N of Cunderdin, 7 Aug. 2009, *J.M. Collins* 639 (CANB, CNS, NSW, PERTH); 3 km N of Wickepin, 22 Oct. 1983, *R.J. Cranfield* 4553 (CANB, PERTH); NW edge of Sheepwash Nature Reserve [SW of Mt Barker], 18 Nov. 1999, *R.J. Cranfield* 14419 (PERTH); Wellstead, 8 Nov. 1978, *R.J. Cranfield s.n.* (CANB, K, PERTH); SW outskirts of Cranbrook, 21 Oct. 2002, *M. Hislop* 2848 (CNS, PERTH); Darling Range Regional Park (30200), Gooseberry Hill, c. 600 m N from top of the Zig Zag, 1 Nov. 2005, *B. Hort* 2670 (PERTH); Toodyay–Bindi Bindi Rd, N Bolgart, 1 km S of Wyening West Rd junction, 16 July 2003, *F. Hort* 1977 (PERTH); Barracca Nature Reserve, A 4070, Gt Northern Hwy, Muchea, in SE corner of reserve, 28 Oct. 2004, *F. Hort & L. Boyle* 2387 (CANB, NSW, PERTH); Flint State Forest, Metro Rd, 6.1 km S from Brookton Hwy then the track SW for 1.6 km, 12 Oct. 2009, *F. & J. Hort* 3479 (CNS, K, PERTH); 7 km N along Knights [Knight] Rd from Porongurup Rd [N of Porongurup], 31 Oct. 1985, *N. Hoyle* 1582 (CANB, PERTH); Beaufort River Nature Reserve, Kojonup to Arthur River, 17 Oct. 2014, *G.J. Keighery & B.J. Keighery* 2673 (K, MEL, PERTH); on S side of Salt River Rd, 8.5 km W of Yetemerup Rd, Stirling Range National Park, 19 Oct. 1999, *G.J. Keighery & N. Gibson* 5571 (CNS, PERTH); on W side of reserve track, 200 m N of Gardner Reserve Rd, Charles Gardner Reserve, S of Tammin, 3 Sep. 1997, *G.J. Keighery & N. Gibson* 5797 (PERTH); Traysurin townsite reserve, 5 km NE of Dudinin, 3 Oct. 2001, *K. Kershaw* KK 2349 (CNS, PERTH); Evan's homestead block, intersection Pound and Kulin–Dudin Rd, 23 Sep. 2001, *S. Murray* 512 (PERTH); 35.3 km NW by road towards Toompup–Ongerup Rd from Boxwood Hill junction, 16 Nov. 1985, *J.M. Powell* 3285 (NSW, PERTH); Talbot Rd Bushland Reserve, Swan View, 8 Nov. 2009, *K.R. Thiele* 3917 (PERTH); on N boundary of Haddleton Nature Reserve [SW of Darkan], c. 2.1 km E along Moodiarrup Rd West, from junction with Gibbs Rd, 21 Sep. 2016, *A. Webb* AW 09084 (PERTH).

Distribution and habitat. Widely distributed in an area roughly bounded by Muchea, Bolgart and Dowerin in the north, and from south-west of Mount Barker to Ongerup in the south; in the Swan Coastal Plain, Jarrah Forest, and western parts of the Avon Wheatbelt, Mallee and Esperance Plains bioregions. Occurs on deep sands or sandy soils over laterite or granite, mostly in the understorey of heath or open mallee woodland.

Phenology. Peak flowering is between September and November. Despite being the most frequently collected species in the *S. tamminensis* subgroup, fruiting specimens are relatively few. Those that do include mature fruit are primarily flowering collections made in the spring months, with a few others made in the early summer. This apparent anomaly is likely to be a consequence of the plant being

very inconspicuous when not flowering and it could be anticipated that fruiting would continue at least through the summer months.

Etymology. From the Latin *annulatus* (furnished with a ring), a reference to the ring of hairs at the base of the ovary.

Conservation status. Together with *S. decussata*, *S. annulata* is the most widely distributed species in the *S. tamminensis* subgroup and is well represented on the conservation estate. No conservation code applies.

Affinities. From Bentham's (1868) treatment of *Leucopogon* until 2005 when the error was detected, this species was mistakenly referred to *Leucopogon cymbiformis* (now *S. cymbiformis*). Bentham did not include the type of *L. cymbiformis* in his list of cited specimens and it may be that he never actually saw material of that species, instead inferring its identity from de Candolle's (1839) scant description in which ovarian hairs are not mentioned. *Styphelia cymbiformis* is a rather uncommon plant that occurs mostly between the Porongurup Range and South Stirling, with a couple of records close to the coast. Its resemblance to *S. annulata* is superficial, with the two species differing in a number of morphological characters. Two of the most distinctive features of *S. annulata* are its acute sepals with green tips, and basal ring of ovarian hairs. The sepals of *S. cymbiformis* by contrast are obtuse and without green tips, and the ovary lacks hairs but is papillose throughout.

In terms of morphological similarity, *S. annulata* is closest to *S. scabrella* and it is with that species that it is most likely to be confused. They share sepals with well-defined, green tips, which are also frequently acute in *S. scabrella*. Differences between them are given below under *S. scabrella*.

Notes. *Styphelia annulata* is the only species from the *S. tamminensis* subgroup that has the combination of spiral phyllotaxis and a basal ring of ovarian hairs. It is noteworthy that the latter character is not evident at the fruiting stage: as the fertilised ovary develops, the tissue expands upwards from the base carrying the hairs along with it, until at maturity the hairs cover the lower half to two thirds of the fruit surface area and the basal ring is no longer apparent (Figure 1C, D).

The above description does not accommodate three anomalous specimens from the York area. Two of these from Wandoo National Park (*F. Hort, J. Hort & M. Hislop* 810; *F. & J. Hort* 2960) differ from the usual form of the species in having rather dense, spreading hairs on both leaf surfaces as well as spreading, abaxial sepal hairs and relatively long bracteoles (almost as long as the sepals). The third specimen from near to Mount Bakewell (*C. Johnson* BS 221) has these same features in addition to sparse hairs on the external corolla tube and lobes, and ovarian hairs that extend well above the basal ring. These localities are well within the geographical range of *S. annulata*, being surrounded in all directions by populations of more or less typical morphotypes of the species. Hybridity suggests itself as a possible explanation for the discrepant morphology observed in these specimens. *Styphelia bracteolosa* is also found in the forest to the south-west of York and, while there are numerous differences between the two species, not least a different phyllotaxis, past hybridisation between the two could be a plausible explanation for the leaf and sepal indumentum and relatively long bracteoles seen in the anomalous specimens cited above. Pending further research these have been referred to *S. aff. annulata*.

Styphelia bracteolosa* Hislop, *sp. nov.

Typus: Flynn State Forest, York, Western Australia [precise locality withheld for conservation reasons], 20 November 1999, F. Hort, J. Hort & M. Hislop 808 (*holo*: PERTH 05442672; *iso*: CANB, CNS, K, MEL, NSW 506418).

Leucopogon sp. Gunapin (F. Hort 808), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 17 June 2022].

Low, spreading *shrub*, to *c.* 50 cm high and 60 cm wide, multi-stemmed from close to base of plant, with a fire-sensitive rootstock. Young *branchlets* with a moderately dense to dense indumentum of variously orientated, straight or curved hairs to *c.* 0.6 mm long. *Leaves* opposite, steeply antrorse, usually \pm appressed; apex mucronate, innocuous to sub-pungent, the mucro \pm straight to distinctly uncinat, 0.1–0.2 mm long; base cuneate or occasionally \pm attenuate; petiole 0.2–0.5 mm long, hairy on the abaxial surface and margins; lamina narrowly ovate to narrowly elliptic, 3–10 mm long, 0.7–2.0 mm wide, \pm concolorous, plano-convex or concave adaxially, longitudinal axis distinctly incurved; adaxial surface shiny or not, sparsely to densely hairy, venation not evident; abaxial surface shiny, with a sparse to dense indumentum of spreading hairs, sometimes \pm glabrescent, with 5–7 primary veins, the midrib distinctly broader than the others, broadly and shallowly grooved to \pm flat between the veins; margins variably ciliate with soft, flexible hairs to 0.5 mm long. *Inflorescence* axillary, erect; axis 2.5–10 mm long, (1)2–6-flowered, with spreading hairs, terminating in a rather elongate bud-rudiment; flowers erect, sessile, usually in widely spaced opposite or subopposite pairs. *Fertile bracts* narrowly ovate, leaf-like, 2.2–4 mm long, 0.7–1.0 mm wide, usually with a \pm uncinat apex, subtended at the base by 2 pairs of opposite sterile bracts. *Bracteoles* narrowly ovate, leaf-like, 2.6–4.2 mm long, 0.8–1.0 mm wide, not keeled, acute, with an uncinat apex; abaxial surface sparsely hairy with spreading hairs; margins variably ciliate. *Sepals* narrowly ovate, 2.3–2.7 mm long, 0.9–1.0 mm wide, narrowly acute to acuminate, the tips usually slightly recurved; abaxial surface with a sparse to moderately dense indumentum of spreading hairs, pale green, often becoming pink in the distal half, venation obscure, often only the mid-vein evident; adaxial surface glabrous; margins ciliate with hairs to *c.* 0.3 mm long. *Corolla tube* pink, cylindrical or very narrowly ovoid, longer than the sepals, 2.7–3.6 mm long, 1.0–1.4 mm wide, glabrous externally, internal surface hairy in the upper half, the hairs extending to a little beyond the anther bases, glabrous below. *Corolla lobes* pink, much shorter than the tube, 1.4–1.8 mm long, 0.5–0.6 mm wide at base, slightly swollen at the base, spreading from the base or a little above and recurved, glabrous externally, internal surfaces with a dense, white indumentum of terete, straight, unornamented hairs and with well-defined, basal tufts projecting into the top of the tube. *Anthers* fully included within the tube, 0.7–1.0 mm long, apex rounded or scarcely emarginate. *Filaments* terete, *c.* 0.2 mm long, attached at anther apex or just below, adnate to tube well below the sinuses. *Nectary* partite, the scales 0.3–0.5 mm long, 0.2–0.3 mm wide, glabrous. *Ovary* narrowly ovoid, 0.9–1.2 mm long, 0.3–0.4 mm wide, hairy (sometimes sparsely) except for a glabrous base, 3-locular, pale green or yellow-green. *Style* scarcely differentiated from ovary apex in flower, *c.* 0.2 mm long, glabrous, included within the corolla tube; stigma slightly expanded. Mature *fruit* not seen. (Figure 2A)

Diagnostic characters. Within the *S. tamminensis* subgroup distinguished by the following character combination: leaves opposite, narrowly ovate or narrowly elliptic, with a distinctly incurved longitudinal axis; abaxial leaf surfaces broadly and shallowly grooved to \pm flat between the veins; leaf apex mucronate, innocuous or sub-pungent, often uncinat; inflorescence (1)2–6-flowered, with leaf-like, uncinat bracts and bracteoles, the latter at least as long as, or more usually distinctly longer than, the sepals; sepals narrowly acute to acuminate, with ciliate margins; external corolla tube glabrous, pink; anthers fully included within the corolla tube; filaments attached at anther apex or just below, adnate

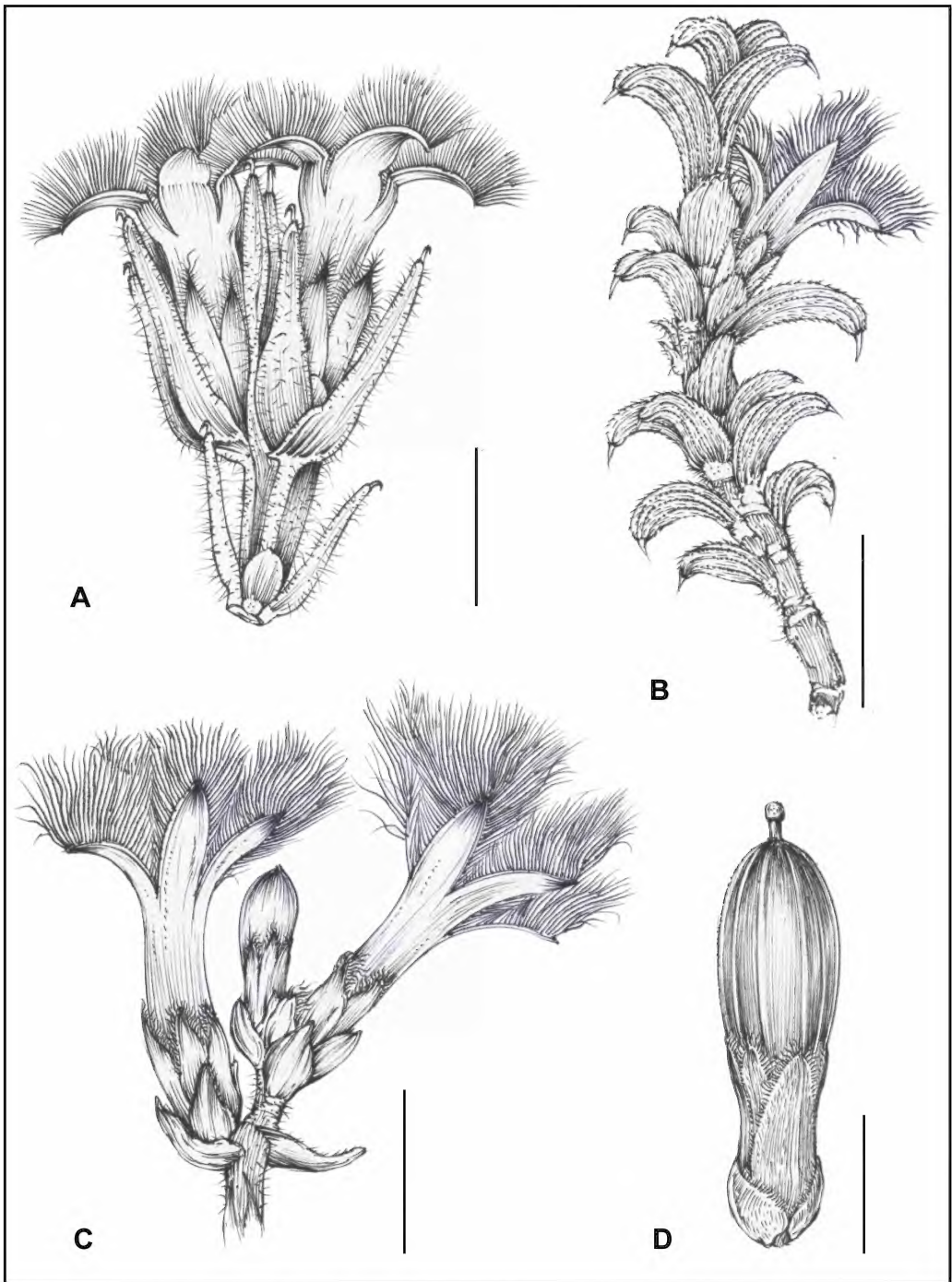


Figure 2. A – *Styphelia bracteolosa*, flowering inflorescence; B – *S. echinulata*, flowering branchlet; C – *S. exilis*, flowering inflorescence; D – *S. exilis*, fruit. Scale bars A = 2 mm; B = 3 mm; C = 2 mm; D = 1 mm. Vouchers *F. Hort* 829 (A), *M. Hislop* 4276 (B), *M. Hislop* 4813 (C), *M. Hislop* 4110 (D). Drawings by Hung Ky Nguyen.

to tube well below the sinuses; ovary hairy; style very short (c. 0.2 mm long), scarcely differentiated from ovary apex in flower.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 10 Dec. 2009, *M. Hislop* 3994 (CNS, K, PERTH); 2 Dec. 1998, *F. Hort* 443 (NSW, PERTH); 22 Nov. 1999, *F. Hort* 811 (PERTH); 22 Nov. 1999, *F. Hort* 812 (CANB, NSW, PERTH); 22 Nov. 1999, *F. Hort* 813 (CANB, NSW, PERTH); 26 Nov. 1999, *F. Hort* 829 (PERTH); 26 Nov. 1999, *F. Hort* 830 (PERTH); 26 Nov. 1999, *F. Hort* 831 (PERTH); 26 Nov. 1999, *F. Hort* 832 (PERTH); 26 Nov. 1999, *F. Hort* 833 (PERTH); 16 Dec. 1999, *F. Hort* 860 (PERTH); 20 Nov. 2000, *F. Hort* 1253 (CANB, PERTH); 22 Nov. 2000, *F. Hort* 1254 (CNS, PERTH); 20 Nov. 1999, *F. Hort*, *J. Hort* & *M. Hislop* 809 (CNS, NSW, PERTH); 12 Nov. 1985, *G.J. Keighery* & *J.J. Alford* 25 (PERTH); 2 July 2010, *C. Puente-Lelièvre*, *M. Hislop* & *E.A. Brown* CPL 37 (NSW, PERTH); 21 Nov. 2018, *A. Sole* & *E. Tomek* AS 334 (PERTH).

Distribution and habitat. Distributed in the Darling Range from north-west of York to west of Beverley, straddling the boundary between the Jarrah Forest and Avon Wheatbelt bioregions. Grows in sand or light loam soils over laterite or granite in open woodland or heath. Commonly associated species include *Eucalyptus wandoo*, *E. drummondii*, *Banksia armata*, *Hakea undulata*, *H. incrassata*, *Melaleuca aspalathoides* and *Allocasuarina humilis*.

Phenology. As with most other members of the *S. tamminensis* subgroup, peak flowering appears to be from late spring to early summer. Mature fruit has not been collected but is likely to be present at least between March and June.

Etymology. From the Latin *bracteola* (bracteole) and *-osus* (abounding in), a reference to the particularly large bracteoles, which are usually longer than the sepals.

Conservation status. The known distribution of *S. bracteolosa* is limited to a fairly small area in the eastern Darling Range, spanning about 30 kilometres on a north-south axis and 11 kilometres from east to west. Most populations occur in a large national park with another known from a nature reserve. Recently listed as Priority Three under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Leucopogon* sp. Gunapin (*F. Hort* 808).

Affinities. *Styphelia bracteolosa* is a highly distinctive species and even within the *S. tamminensis* subgroup is unlikely to be confused with any others. The relatively long inflorescence with openly arranged flowers and foliose, uncinat bracts and bracteoles are diagnostic.

Three other members of the *S. tamminensis* subgroup grow in the Darling Range in the general vicinity of Perth. *Styphelia roseola* occurs to the north of the range of *S. bracteolosa*, beginning in the Bindoon–Julimar area. *Styphelia bracteolosa* differs from *S. roseola* in its much longer, uncinat fertile bracts (2.2–4.0 mm long *cf.* 0.3–0.7 mm in *S. roseola*) and bracteoles (2.6–4.2 mm long *cf.* 1.0–1.6 mm), much longer, multi-flowered inflorescence axes (2.5–10 mm long *cf.* 0.3–0.8 mm), acute rather than obtuse sepals, and glabrous external corolla tubes (*cf.* usually hairy).

The distribution of the widespread *S. annulata* overlaps that of *S. bracteolosa* although there are no records of the two growing together. *Styphelia bracteolosa* is easily distinguished from *S. annulata* by its opposite rather than spiral phyllotaxis, and uncinat bracteoles that are equal to or longer than the sepals (*cf.* bracteoles shorter than the sepals and with straight tips in *S. annulata*).

At the southern extent of its range the distribution of *S. bracteolosa* approaches that of *Styphelia recurva*, although again there are no records of the two species co-occurring. *Styphelia recurva* is readily distinguished from *S. bracteolosa* by its spiral, rather than opposite, phyllotaxis and sharply pungent leaves.

Styphelia crassifolia (Sond.) F.Muell., *Fragm.* 6(42): 33 (1867); *Leucopogon crassifolius* Sond. in J.G.C. Lehmann, *Pl. Preiss.* 1(2): 316 (1845). Type: ‘In rupestribus collium Konkoberup, promontorii Cape Riche’ [Western Australia], 19 November 1840, *L. Preiss* 386 (*syn*: G 00342145 image!, P 00760527 image!, LD 1062762 image!, MEL 1513026 image!, MEL 1513027!).

Leucopogon sp. Twertup (K.R. Newbey 10859), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [before February 2020].

Distribution. A somewhat disjunct distribution mostly centred on the Cape Riche area in the west and the Fitzgerald River National Park in the east, with apparent outliers north of Cheyne Beach and in the Chillinup area; all within the Esperance Plains bioregion.

Conservation status. The species is widespread and locally common in the Fitzgerald River National Park. No conservation code is required.

Notes. Although Bentham (1868) cited the type of *Leucopogon crassifolia* in his treatment of that species, he was confused by its superficial similarity to another common but currently unnamed congener from the south coast of Western Australia, now known by the informal name, *Styphelia* sp. South Coast (J.M. Powell 3374). In regard to critical aspects of his description of *S. crassifolia* (i.e. ovary locule number: 5 rather than 3; style length: ‘rather long’ rather than very short or \pm obsolete; fruit shape: cylindrical rather than obovoid; nectary character: truncate rather than clearly partite), there is no doubt that Bentham had mostly been studying the unnamed taxon, rather than *S. crassifolia* s. str. As noted above in the general discussion of the *S. tamminensis* subgroup, he had problems in interpreting the gynoeceum character in this species group, and again this seems the likely cause of the error here. This is made clear in the following passage: ‘In several of the specimens a few flowers may be met with, probably diseased, having a longer tube to the corolla, and an elongated, apparently barren ovary, with a short style’. There seems little doubt that the ‘diseased’ flowers that he is describing here are in fact the normal flowers of *S. crassifolia* s. str.

All publications have followed Bentham (1868) in applying the name *S. crassifolia* to the unnamed taxon and the name was similarly misapplied in the phylogeny of Puente-Lelièvre *et al.* (2016). While *S.* sp. South Coast is also a member of Group X it does not belong in the *S. tamminensis* subgroup but is closely related to *S. corynocarpa* (Sond.) F.Muell. *Styphelia* sp. South Coast will be formally described in a forthcoming paper.

Styphelia cymbiformis (A.Cunn. ex DC.) F.Muell., *Fragm.* 6(42): 34 (1867); *Leucopogon cymbiformis* A.Cunn. ex DC., *Prodr.* 7(2): 750 (1839). Type: ‘Ad Novae-Hollandiae oram meridionalem’ [Western Australia], s. dat., *W. Baxter* s.n. (*holo*: GDC G00455446 image!; *iso*: K 000347895 image!, PERTH 01598376!).

Distribution. Mostly occurs in a narrow east-west band between the Porongurup Range and South Stirling, with two outlying collections close to the coast at Albany and in Waychinicup National Park; within the Esperance Plains and adjacent Jarrah Forest bioregions.

Conservation status. A short-range endemic that is currently listed as Priority Two under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–).

Notes. *Styphelia cymbiformis* was for many years confused with the common *S. annulata*, as discussed above under the treatment of that species.

In gross morphology *S. cymbiformis* is very similar to *S. crassifolia*. Apart from the distinguishing characters used in the key, *S. cymbiformis* typically has shorter leaves. The two species are allopatric with the range of *S. cymbiformis* occurring to the west of that of *S. crassifolia*.

Styphelia decussata Hislop, Crayn & Puente-Lel., *Austral. Syst. Bot.* 33(2): 149 (2020); *Leucopogon tamminensis* E.Pritz. var. *australis* E.Pritz., in F.L.E. Diels & E.G. Pritzel, *Bot. Jahrb. Syst.* 35(2–3): 479 (1904). *Type*: ‘In districtu Eyre interior pr. Hammersley River in fruticetis arenosis’ [Western Australia], 13 Oct. 1901, *L. Diels* 5817 (*syn*: PERTH 01598414!, PERTH 09008535!).

Distribution. Widespread, from Corrigin in the north, south to Boxwood Hill and east to near Munglinup; in the Avon Wheatbelt, Mallee and Esperance Plains bioregions.

Conservation status. Widely distributed and well represented on the conservation estate. No conservation code is required.

Notes on type collection. The two, small fragments housed at PERTH were obtained by C.A. Gardner during a visit to B in 1937 and are likely to represent the only extant type material, with many of Diels’ collections destroyed during the bombing of Berlin in the second world war (Gibson 2018). No additional duplicates were located on JSTOR Global Plants while researching the recently published nomenclatural paper (Crayn *et al.* 2020). According to Gibson (2018), Diels mostly collected unicates and few duplicates found their way to other herbaria.

Styphelia echinulata Hislop, *sp. nov.*

Typus: north-east of Beacon, Western Australia [precise locality withheld for conservation reasons], 9 September 2013, *M. Hislop* 4276 (*holo*: PERTH 08633649; *iso*: CANB, K, MEL, NSW).

Leucopogon sp. Karroun Hill (K.R. Thiele 4167), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 17 June 2022].

Compact, tangled *shrub* to c. 100 cm high and 100 cm wide, multi-stemmed from close to base of plant; fire-tolerance of rootstock unknown. Young *branchlets* with a sparse or moderately dense indumentum of patent or retrorse hairs to c. 0.1 mm long. *Leaves* helically arranged, usually variably antrorse or sometimes \pm patent; apex mucronate, pungent or sub-pungent, the mucro recurved, 0.2–0.5 mm long; base cuneate; petiole 0.1–0.3 mm long, variably hairy on both surfaces and margins; lamina ovate to elliptic or narrowly so, 1.4–2.8 mm long, 1.0–1.6 mm wide, \pm concolorous, thick, strongly concave, sometimes \pm stem-clasping in the lower half, sometimes \pm plano-convex in the upper half, longitudinal axis strongly recurved; adaxial surface slightly shiny, with a zone of long hairs towards the base and stiff, shorter hairs in the upper half, venation not evident; abaxial surface slightly shiny, with 5–7 broad, primary veins and deep, very narrow grooves between, very sparsely hairy or \pm glabrous on the outer surface of the veins, with stiff, short hairs within the grooves; margins usually with short, stiff, antrorse hairs <0.05 mm long or \pm glabrous. *Inflorescence* axillary, erect; axis 0.6–1.2

mm long, 1- or 2-flowered, subterete, with a sparse indumentum or \pm glabrous, terminating in a budrudiment; flowers erect, sessile. *Fertile bracts* ovate to broadly ovate, 0.4–0.5 mm long, 0.3–0.4 mm wide, usually subtended by 3 sterile bracts, the basal 2 opposite, occasionally only the basal bracts present. *Bracteoles* ovate or broadly ovate, 0.8–1.3 mm long, 0.7–1.0 wide, at least the inner keeled, acute or subacute; abaxial surface sparsely hairy; margins ciliolate. *Sepals* ovate or narrowly ovate, 1.4–2.0 mm long, 0.7–1.1 mm wide, obtuse to subacute; abaxial surface rather sparsely hairy with spreading hairs, green or yellow-green throughout, only the mid-vein evident; adaxial surface with a discrete hair tuft towards the base, sometimes reduced to a few hairs; margins ciliate with hairs to *c.* 0.2 mm long. *Corolla tube* white, ellipsoid to obovoid, sometimes narrowly so, a little longer than the sepals, 1.5–2.0 mm long, 1.2–1.6 mm wide, glabrous externally, internal surface with an apical band of hairs projecting into the tube (occasionally the hairs sparse), the remainder glabrous. *Corolla lobes* white, shorter than the tube, 0.8–1.2 mm long, 0.5–0.6 mm wide at base, spreading from close to the base and recurved, glabrous externally, internal surfaces with a dense indumentum of terete, \pm straight and essentially unornamented hairs. *Anthers* partially exerted from the tube by 1/8–1/4 of their length, 0.6–1.0 mm long, apex rounded or scarcely emarginate. *Filaments* terete, 0.1–0.2 mm long, attached to anther 3/4–7/8 above base, adnate to tube a little below the sinuses. *Nectary* partite, the scales 0.3–0.5 mm long, 0.3–0.4 mm wide, glabrous. *Ovary* ellipsoid or narrowly ellipsoid, 0.6–0.8 mm long, 0.4–0.5 mm wide, glabrous, 3(4)-locular, pale green or yellow-green. *Style* scarcely differentiated from the ovary apex in flower, more clearly defined in fruit, *c.* 0.2 mm long, glabrous, included within the corolla tube; stigma not or scarcely expanded. *Fruit* \pm cylindrical, 2.5–3.2 mm long (inclusive of gynophore), 1.0–1.2 mm wide, much longer than the sepals, circular in section, with a well-defined gynophore; surface glabrous, \pm dry, smooth (mesocarp poorly developed), with pale, longitudinal ribs; apex acute, tapering smoothly to the base of the persistent style. (Figure 2B)

Diagnostic characters. Within the *S. tamminensis* subgroup distinguished by the following character combination: leaves helically arranged, ovate to elliptic or narrowly so with a strongly recurved longitudinal axis; abaxial leaf surfaces with deep, narrow grooves and short hairs within the grooves; leaf apex mucronate, pungent or sub-pungent; inflorescence 1- or 2-flowered; anthers tips just exerted from the corolla tube; filaments attached to anther 3/4–7/8 above base, adnate to tube just below the sinuses; ovary glabrous; style very short (*c.* 0.2 mm long), scarcely differentiated from ovary apex in flower; fruit \pm dry, cylindrical, with an acute apex.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 9 Sep. 2013, *M. Hislop* 4277 (CANB, CNS, PERTH); 22 Sep. 1982, *K. Newbey* 9608 (PERTH); 26 June 2011, *K.R. Thiele* 4167 (CANB, PERTH).

Distribution and habitat. Currently known from scattered localities from the Bonnie Rock area in the west to the Diemals area in the east; in the far west of the Coolgardie bioregion and far east of the Yalgoo bioregion. It is apparently restricted to the immediate vicinity of decomposed granitic breakaways. Associated plant species include *Melaleuca hamata*, *Allocasuarina acutivalvis*, *Xerolirion divaricata* and *Acacia aneura s. lat.*

Phenology. The few available specimens indicate that the species has a lengthy flowering period, at least from early winter to early spring. To date the only collections have been made in June or September and all have buds, flowers and mature fruit present.

Etymology. From the Latin *echinulatus* (with very small prickles), a reference to the short, stout hairs of the distal, adaxial leaf surfaces and margins.

Conservation status. *Styphelia echinulata* is only known from three populations: one in a nature reserve, one from unallocated crown land and the third from a rather vague locality, but which seems unlikely to be on the conservation estate. While it is probable that the species is restricted to a specific landform, its known distribution encompasses remote and botanically poorly known country and so the chances of new populations coming to light over time appears high. Recently listed as Priority Two under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Leucopogon* sp. Karroun Hill (K.R. Thiele 4167).

Affinities. *Styphelia echinulata* has the most inland distribution of any species within the *S. tamminensis* subgroup and is the only member of that grouping to occur in either the Coolgardie or Yalgoo bioregions. Those members of the subgroup that are closest geographically are *S. subglauca* and *S. scabrella*, both of which have distributions that extend close to the southern and eastern boundaries of the Coolgardie bioregion. The two can be easily distinguished from *S. echinulata* by their foliar morphology: *S. subglauca* has a non-mucronate, usually obtuse leaf apex (rather than mucronate, pungent or sub-pungent) and *S. scabrella* has leaf blades that are markedly incurved in their distal half (rather than distinctly recurved).

Away from the *S. tamminensis* subgroup and in terms of gross morphology, *S. echinulata* bears a strong resemblance to acute-leaved morphotypes of the variable *S. hamulosa* (E.Pritz.) Sleumer. Differences in the gynoecium provide the most reliable means of distinguishing between the two, especially if plants are in fruit: *S. echinulata* has an acute fruit apex that tapers smoothly to the base of the persistent and very short style, whereas in *S. hamulosa* the fruit apex is obtuse and the style is always shed well before maturity. In flowering-only specimens, the much shorter style (c. 0.2 mm long) of *S. echinulata*, which is barely differentiated from the ovary apex, is a clear point of difference. In *S. hamulosa* by contrast the style is at least 1 mm long, as long or longer than the corolla tube, and abruptly differentiated from the ovary apex. In addition, while *S. echinulata* has a 3(4)-locular ovary, in *S. hamulosa* it is 5-locular. It is also noteworthy that while the leaf apex may be either acute or obtuse in *S. hamulosa*, the variant of the species that occurs in the Coolgardie bioregion usually has an obtuse apex, or if occasionally acute, then a mucro is either lacking or very short (to c. 0.2 mm long). This provides an easily observed feature to assist in distinguishing between the two in the field, as does a difference in habitat preference. Whereas *S. echinulata* is apparently restricted to the environs of decomposed granitic breakaways, *S. hamulosa* in the Coolgardie bioregion (and indeed across most of its range) occurs on sand plain.

***Styphelia exilis* Hislop, sp. nov.**

Typus: north-east of Manypeaks, Western Australia [precise locality withheld for conservation reasons], 8 November 2019, M. Hislop 4813 (*holo:* PERTH 09172955; *iso:* CANB, MEL, NSW).

Leucopogon sp. Manypeaks (A.S. George 6488), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 17 June 2022].

Low, spreading *shrub* to c. 25 cm high and 25 cm wide, multi-stemmed from close to base of plant, with a fire-sensitive rootstock. Young *branchlets* with a sparse to moderately dense indumentum of short, patent hairs to c. 0.1 mm long. *Leaves* opposite, usually clearly decussate, steeply antrorse to antrorse-appressed; apex non-mucronate, narrowly obtuse; base attenuate to cuneate; petiole 0.1–0.3 mm long, usually glabrous, sometimes with a few marginal hairs; lamina usually very narrowly ovate or occasionally \pm linear, 2.3–4.5 mm long, 0.4–1.0 mm wide, \pm concolorous, usually plano-

convex or sometimes adaxially concave, longitudinal axis gently incurved; adaxial surface slightly shiny, sparsely hairy, venation not evident; abaxial surface slightly shiny, glabrous or sparsely hairy, with 5 primary veins, the mid-vein distinctly broader than the others, shallowly grooved to \pm flat between the veins; margins usually with a few short, stiff hairs <0.05 mm long, less often glabrous. *Inflorescence* axillary, erect; axis 1.5–3.5 mm long, 1–4-flowered, somewhat compressed, with a sparse to moderately dense indumentum, terminating in a bud-rudiment; flowers erect, sessile. *Fertile bracts* narrowly ovate to ovate, sometimes leaf-like, 0.7–1.3 mm long, 0.4–0.5 mm wide, subtended by 3 or 4 sterile bracts (the 2 basal bracts opposite, laterally positioned, with a third on the abaxial surface inserted a little higher, and sometimes a fourth, positioned opposite on the adaxial surface). *Bracteoles* ovate, 0.8–1.0 mm long, 0.5–0.6 mm wide, obscurely keeled, acute or subacute; abaxial surface glabrous; margins ciliolate. *Sepals* narrowly ovate, 1.3–1.6 mm long, 0.5–0.6 mm wide, obtuse to subacute; abaxial surface glabrous, mostly pale green but often with some pink tinges in the distal half and towards the margins, venation obscure, with only the mid-vein evident; adaxial surface with a discrete, sometimes sparse, patch of hairs towards the base; margins ciliate with hairs to *c.* 0.2 mm long. *Corolla tube* white, sometimes with pink tinges, cylindrical, much longer than the sepals, 1.8–2.3 mm long, 0.7–0.8 mm wide, glabrous externally, internal surface with an apical band of hairs projecting into the tube, the remainder glabrous. *Corolla lobes* white, often with pink tinges, much shorter than the tube, 0.8–1.3 mm long, 0.4–0.5 mm wide at base, spreading from the base and recurved, glabrous externally, internal surfaces with a dense indumentum of terete, \pm straight and essentially unornamented hairs. *Anthers* fully included within the tube (the tips \pm held at the orifice), 0.8–1.1 mm long, apex rounded. *Filaments* terete, *c.* 0.1 mm long, attached at anther apex, adnate to tube a little below sinuses. *Nectary* partite, the scales 0.2–0.3 mm long, 0.15–0.20 mm wide, glabrous. *Ovary* ellipsoid to obovoid, 0.3–0.4 mm long, 0.2–0.3 mm wide, glabrous, 3-locular, pale green or yellow-green. *Style* distinct and abruptly differentiated from ovary apex, 0.3–0.4 mm long, glabrous, included within the corolla tube; stigma slightly expanded. *Fruit* cylindrical, usually slightly curved with the style base \pm excentric, 2.2–2.5 mm long (inclusive of gynophore), 0.7–0.8 mm wide, much longer than the sepals, circular in section with a well-defined gynophore; surface glabrous, \pm dry, smooth (mesocarp poorly developed), with prominent, pale, slightly raised longitudinal ribs; apex obtuse; style either persistent or shed at, or close to, maturity. (Figure 2C, D)

Diagnostic characters. Within the *S. tamminensis* subgroup distinguished by the following character combination: leaves opposite, very narrowly ovate to more or less linear; leaf apex non-mucronate, narrowly obtuse; inflorescence 1–4-flowered; anthers included within the corolla tube; filaments attached at anther apex, adnate to tube just below the sinuses; ovary glabrous; style very short (0.3–0.4 mm long) but distinct and abruptly differentiated from the ovary apex; fruit \pm dry, cylindrical, with prominent, pale longitudinal ribs and an obtuse apex.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 19 Oct. 2017, *S. Barrett* SB 2264 (PERTH); 10 Dec. 1964, *A.S. George* 6488 (PERTH); 7 Jan. 2010, *M. Hislop* 4110 (CANB, PERTH); 16 Oct. 2018, *D.A. Rathbone* DAR 1010 (PERTH); 30 Oct. 2018, *D.A. Rathbone* DAR 1011 (PERTH); 31 Oct. 2018, *D.A. Rathbone* DAR 1012 (PERTH); 2 Nov. 2018, *D.A. Rathbone* DAR 1013 (PERTH).

Distribution and habitat. Currently known only from a small area between Manypeaks and Wellstead in the far west of the Esperance Plains bioregion. It occurs in white or yellow sand over granite or laterite in low open woodland or heath. Associated species include *Eucalyptus marginata*, *Taxandria spathulata*, *Melaleuca striata*, *Hakea cucullata* *Agonis theiformis* and *Banksia mucronulata*.

Phenology. The main flowering period is apparently between October and December. A specimen collected in early January (*M. Hislop* 4110) has fruit at various stages of maturity as well as some flowers at anthesis.

Etymology. From the Latin *exilis* (small, slender), a reference to the small stature of the plant and the slender leaves and floral parts.

Conservation status. Listed as Threatened (Endangered) in Western Australia under the name *Leucopogon* sp. Manypeaks (A.S. George 6488) (State of Western Australia 2022). *Styphelia exilis* appears restricted to a few, mostly small populations, one of which occurs in a national park.

Affinities. *Styphelia exilis* is morphologically typical of the *S. tamminensis* subgroup except for its fruit apex, which is obtuse rather than markedly tapered towards the style base as per the other species, excluding *S. incerta*.

The only other *Styphelia* with opposite leaves that occurs in the Esperance Plains or the adjoining Southern Jarrah Forest, and hence the only species likely to be confused with *S. exilis*, is *S. decussata*. The latter is readily distinguished by its consistently 1-flowered inflorescence, hairy ovary with style not differentiated from the apex, and strongly concave leaves with a densely hairy, adaxial surface. In *S. exilis* by contrast, the inflorescence is 1–4-flowered, the ovary is glabrous and with a clearly differentiated style 0.3–0.4 mm long, and the leaves are usually plano-convex (sometimes \pm concavo-convex in younger leaves) with the flat, adaxial surface never more than sparsely hairy.

***Styphelia hyalina* Hislop, sp. nov.**

Typus: west of Three Springs, Western Australia [precise locality withheld for conservation reasons], 14 November 2004, *M. Hislop & A. Tinker* MH 3351 (*holo:* PERTH 07202970; *iso:* CANB, CNS, HO, K, MEL, NSW 830977).

Leucopogon sp. Yandanooka (*M. Hislop* 2507), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 17 June 2022].

Low, spreading *shrub*, to *c.* 40 cm high and 40 cm wide, branching close to base of plant, with a fire-sensitive rootstock. Young *branchlets* with a sparse to moderately dense indumentum of patent to retrorse, straight or curved hairs to *c.* 0.2 mm long. *Leaves* opposite, densely arranged about the inflorescence, steeply antrorse to antrorse-appressed; apex mucronate, pungent or sub-pungent, the mucro straight, 0.1–0.3 mm long; base mostly cuneate, occasionally \pm rounded; petiole 0.2–0.5 mm long, usually sparsely hairy on the abaxial surface and margins, sometimes \pm glabrous throughout; lamina ovate or narrowly ovate, 2.5–5.0 mm long, 1.2–2.2 mm wide, somewhat discolorous, strongly concave adaxially, longitudinal axis usually distinctly incurved, occasionally \pm straight; adaxial surface matt, \pm glaucous, sparsely hairy to \pm glabrous, venation not evident or with 1–3 slightly raised veins; abaxial surface usually darker, shiny, glabrous or with a sparse to moderately dense indumentum of very short, coarse hairs, with 5–7 primary veins, shallowly grooved to \pm flat between the veins; margins ciliate with stiff hairs to *c.* 0.3 mm long. *Inflorescence* axillary, erect; axis 0.2–0.4 mm long, 1-flowered, shortly hairy, apparently terminating in a flower, bud-rudiment absent; flowers erect, sessile. *Fertile bracts* ovate to depressed-ovate, 0.3–0.5 mm long, 0.3–0.5 mm wide, with a larger sterile bract on the adaxial axis surface and 2 opposite, basal bracts on the same plane as the bracteoles. *Bracteoles* ovate or broadly ovate, 0.7–1.2 mm long, 0.6–0.8 mm wide, not keeled, obtuse; abaxial surface glabrous;

margins glabrous. *Sepals* narrowly ovate, 1.8–2.5 mm long, 0.7–1.0 mm wide, obtuse; abaxial surface glabrous, pale green in the lower half often becoming pink towards the apex, venation obscure, only the mid-vein evident; adaxial surface glabrous; margins broadly hyaline, glabrous. *Corolla tube* red, \pm cylindrical or very narrowly ellipsoid, longer than the sepals, 2.0–2.9 mm long, 0.8–1.1 mm wide, glabrous externally, internal surface hairy in the upper half almost to the base of the anthers, glabrous below. *Corolla lobes* red, shorter than the tube, 1.5–2.1 mm long, 0.4–0.5 mm wide at base, spreading from the base and recurved, glabrous externally, internal surfaces with a dense, white indumentum of terete, straight and unornamented hairs. *Anthers* fully included within the tube or partially exerted by up to 1/8 of their length, 0.8–1.3 mm long, apex rounded or scarcely emarginate. *Filaments* terete, 0.1–0.2 mm long, attached at anther apex or just below, adnate to tube a little below the sinuses. *Nectary* partite, the scales 0.4–0.6 mm long, 0.15–0.25 mm wide, glabrous. *Ovary* very narrowly ovoid to \pm cylindrical, 1.3–1.8 mm long, 0.3–0.4 mm wide, glabrous, 3-locular, pale green or yellow-green. *Style* not or scarcely differentiated from ovary apex in flower, more clearly defined in fruit, *c.* 0.2 mm long, glabrous, included within the corolla tube; stigma not or scarcely expanded. *Fruit* very narrowly ovoid to \pm cylindrical, 2.6–3.4 mm long, 0.8–0.9 mm wide, much longer than the sepals, circular in section with a well-defined gynophore; surface glabrous, \pm dry, smooth (mesocarp poorly developed), with prominent, pale longitudinal ribs; apex acute, tapering smoothly to the base of the persistent style. (Figure 3)

Diagnostic characters. Within the *S. tamminensis* subgroup distinguished by the following character combination: leaves opposite, ovate or narrowly ovate, with the longitudinal axis usually distinctly incurved; abaxial leaf surfaces broadly and shallowly grooved to \pm flat between the veins; leaf apex mucronate, pungent or sub-pungent; inflorescence 1-flowered; sepals entirely glabrous abaxially, with glabrous, hyaline margins; external corolla tube glabrous, red; anthers either fully included in the corolla tube or the tips just exerted; filaments attached to anther in the upper quarter of anther length, adnate to tube just below the sinuses; ovary glabrous; style very short (*c.* 0.2 mm long), scarcely differentiated from ovary apex in flower; fruit \pm dry, very narrowly ovoid to \pm cylindrical, with an acute apex.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 25 Oct. 1992, *E.A. Griffin* 7615 (PERTH); 3 Dec. 1992, *E.A. Griffin* 8098 (PERTH); 10 Dec. 2001, *M. Hislop* 2507 (CANB, CNS, MEL, PERTH); 9 Dec. 2001, *M. Hislop* & *A. Tinker* MH 2501 A (NSW, PERTH) & 2501 B (PERTH); 9 Dec. 2001, *M. Hislop* & *A. Tinker* MH 2503 A (PERTH) & 2503 B (CANB, PERTH); 14 Nov. 2004, *M. Hislop* & *A. Tinker* MH 3354 (MEL, PERTH); 7 Nov. 2011, *M. Holmes* MHB 712 (PERTH); Nov. 2002, *A. Tinker s.n.* (PERTH).

Distribution and habitat. Distributed from south of Mingenew to west of Three Springs, in the Geraldton Sandplains bioregion. It grows in species-rich heathland in sand or loam soils, on lateritic uplands and often in association with breakaways. Species with which it has been recorded include *Allocasuarina campestris*, *Gastrolobium plicatum*, *Melaleuca tinker*, *Petrophile shuttleworthiana*, *P. chrysantha* and *Dodonaea ericoides*.

Phenology. The main flowering period is between October and December although a flush of flowering in June has been observed in one population, apparently in response to the first rains of autumn. Curiously, the only collection with mature fruit was made in December, although presumably fruit would more usually be present in the period between March and June.

Etymology. From the Latin *hyalinus* (transparent), a reference to the broad, hyaline sepal margins.



Figure 3. *Styphelia hyalina*. A – flowering plant *in situ*; B – flowering branchlet; C – leaf, abaxial surface. Scale bars B = 3 mm; C = 2 mm. Vouchers M. Hislop & A. Tinker MH 2501A (A), M. Hislop & A. Tinker MH 3351 (B, C). Photograph by Michael Hislop. Drawings by Hung Ky Nguyen.

Conservation status. *Styphelia hyalina* is currently known from six or seven populations, one of which is in a nature reserve. While it is often locally common, its geographic range is quite restricted: about 30 kilometres on a north-south axis and 20 kilometres from east to west. Recently listed as Priority Three under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Leucopogon* sp. Yandanooka (M. Hislop 2507).

Affinities. There are three other members of the *S. tamminensis* subgroup in the Geraldton Sandplain bioregion: *S. tamminensis*, *S. williamsiorum* and *S. pallens*. Of these, only *S. williamsiorum* and *S. pallens* have opposite leaves and are therefore more likely to be confused with *S. hyalina*. *Styphelia hyalina* can be distinguished from both species by its glabrous, rather than hairy, external corolla tube and ovary, glabrous sepal margins (*cf.* ciliate in *S. williamsiorum* and *S. pallens*), anthers (presented at the throat of the corolla tube *cf.* held well below the throat), and filaments (attached at or very close to the anther apex *cf.* at a point 2/3–3/4 above the anther base).

The closest relative of *S. hyalina* seems likely to be *S. roseola*. Differences between the two are discussed under that species.

Styphelia incerta* Hislop, *sp. nov.

Typus: Dragon Rocks Nature Reserve [south-east of Hyden], Western Australia [precise locality withheld for conservation reasons], 10 November 2001, *M. Hislop* 2446 (*holo*: PERTH 05917883; *iso*: CNS, NSW 832206).

Leucopogon sp. Lake King (A.J.G. Wilson 65), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 17 June 2022].

Small, spreading, and often compact *shrub*, to *c.* 30 cm high and 30 cm wide, branching close to base of plant, with a fire-sensitive rootstock. Young *branchlets* with a sparse or moderately dense indumentum of short hairs <0.05 mm long. *Leaves* helically arranged, variably antrorse to \pm patent; apex acute, non-mucronate or with a sub-pungent to pungent mucro 0.1–0.5 mm long; base mostly cuneate or sometimes rounded; petiole 0.1–0.3 mm long, glabrous or with a few marginal hairs; lamina broadly ovate to depressed-ovate or broadly elliptic to transversely elliptic, 0.9–2.0 mm long, 1.0–2.2 mm wide, thick, \pm concolorous and becoming shiny at maturity but the abaxial surface somewhat paler and \pm glaucous on young growth, strongly concave, sometimes \pm stem-clasping in the lower half, longitudinal axis very strongly recurved; adaxial surface with a few hairs towards the base and glabrous or \pm scabrous above, venation not evident; abaxial surface glabrous, with 7–9 primary veins and shallow, open grooves between; margins usually glabrous, occasionally with a few, very short hairs <0.05 mm long. *Inflorescence* axillary, erect; axis 1.0–2.4 mm long, 1–3-flowered, subterete to bluntly angular, with a moderately dense indumentum of short hairs, terminating in a bud-rudiment; flowers erect, sessile. *Fertile bracts* ovate to broadly ovate, 0.6–1.0 mm long, 0.5–0.7 mm wide, subtended by 3 or 4 sterile bracts. *Bracteoles* ovate to broadly ovate, 0.9–1.3 mm long, 0.7–0.9 mm wide, keeled, obtuse to acute; abaxial surface glabrous, margins ciliate. *Sepals* narrowly ovate to ovate, 1.6–2.3 mm long, 0.7–1.0 mm wide, obtuse to acute; abaxial surface glabrous, pale green to straw-coloured, with a reddish marginal band at least in the upper half, only the mid-vein evident; adaxial surface with sparse hairs towards the base and apex or \pm glabrous; margins ciliate with rather crinkled hairs to *c.* 0.2 mm long. *Corolla tube* white or partially flushed pink towards the apex, cylindrical or very narrowly ovoid, longer than the sepals, 2.2–2.8 mm long, 0.9–1.0 mm wide, glabrous externally, internal surface sparsely hairy to a point below the anther bases, glabrous below that. *Corolla lobes* white, variably flushed

pink, shorter than the tube, 1.1–1.5 mm long, 0.5–0.7 mm wide at base, spreading from the base and recurved, glabrous externally, internal surface with a dense indumentum of \pm straight and essentially unornamented hairs. *Anthers* fully included within the tube, 0.7–1.1 mm long, apex scarcely emarginate. *Filaments* terete, 0.1–0.2 mm long, attached to anther *c.* 3/4 above base, adnate at a point 1/2–2/3 the length of the tube above the base. *Nectary* partite, the scales 0.2–0.3 mm long, 0.2–0.3 mm wide, thick, glabrous. *Ovary* ellipsoid to ovoid, 0.4–0.5 mm long, 0.3–0.4 mm wide, glabrous, 3-locular, pale green to straw-coloured. *Style* abruptly differentiated from ovary apex, 1.4–1.8 mm long, pink-red, finely scabrous, included within the corolla tube; stigma not or scarcely expanded. *Fruit* \pm cylindrical to very narrowly obovoid, 2.7–3.1 mm long (inclusive of gynophore), 0.8–1.1 mm wide, much longer than the sepals, circular in section, with a well-defined gynophore; surface glabrous, \pm dry, smooth (mesocarp poorly developed), with pale longitudinal ribs, usually darkly pigmented towards the apex; apex obtuse to subacute; style shed before maturity. (Figure 4A, B)

Diagnostic characters. Within the *S. tamminensis* subgroup distinguished by the following character combination: leaves helically arranged, broadly ovate to depressed-ovate or broadly elliptic to transversely elliptic with the longitudinal axis very strongly recurved; abaxial leaf surfaces with shallow, open grooves; leaf apex mucronate or not, pungent or sub-pungent; inflorescence 1–3-flowered; anthers included within the corolla tube; filaments attached to anther in the upper quarter of anther length, adnate to tube at a point 1/2–2/3 the length of the tube above the base; ovary glabrous; style 1.4–1.8 mm long, abruptly differentiated from ovary apex; fruit \pm dry, cylindrical to very narrowly obovoid, with an obtuse to subacute apex.

Other specimens examined. WESTERN AUSTRALIA: 15 Apr. 2006, G. Byrne 1930 (CNS, PERTH); 28 Oct. 1991, A.M. Coates 3377 (PERTH); 14 Dec. 1960, A.S. George 2264 (PERTH); 25 Apr. 1969, A.S. George 9282 (PERTH); 4 July 2002, C. Godden & A. Coates DR 12.2 (PERTH); 29 Oct. 1975, J.W. Green 4567 (PERTH); 13 Nov. 2001, M. Hislop 2480 (CANB, CNS, PERTH); 22 May 2002, M. Hislop & F. Hort MH 2666 (NSW, PERTH); 22 May 2002, M. Hislop & F. Hort MH 2667 (CANB, PERTH); 24 May 2004, M. Hislop & F. Hort MH 3231 (CNS, MEL, PERTH); 23 Aug. 2017, M. Hislop 4716 (CNS, MEL, PERTH); 26 Mar. 1987, A.J.G. Wilson 65 (PERTH).

Distribution and habitat. Distributed from a little south of Hyden south and eastwards to an area south-west of Lake King, in the Mallee bioregion. Grows in sandy soils mostly over laterite, in open mallee woodland or heath. Associated species include *Eucalyptus pleurocarpa*, *Allocasuarina acutivalvis*, *Banksia sphaerocarpa*, *Beaufortia puberula*, *Eremaea pauciflora* and *Microcorys obovata*.

Phenology. The main flowering period is between October and December although some flowering may continue into the late autumn–early winter period. Fruit at or close to maturity has been collected in April, May and August.

Etymology. From the Latin *incertus* (uncertain, doubtful), an allusion to the species' somewhat problematic status within the *S. tamminensis* subgroup.

Conservation status. Has a fairly restricted distribution but is known to occur in three nature reserves and is often locally common. Recently listed as Priority Three under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Leucopogon* sp. Lake King (A.J.G. Wilson 65).

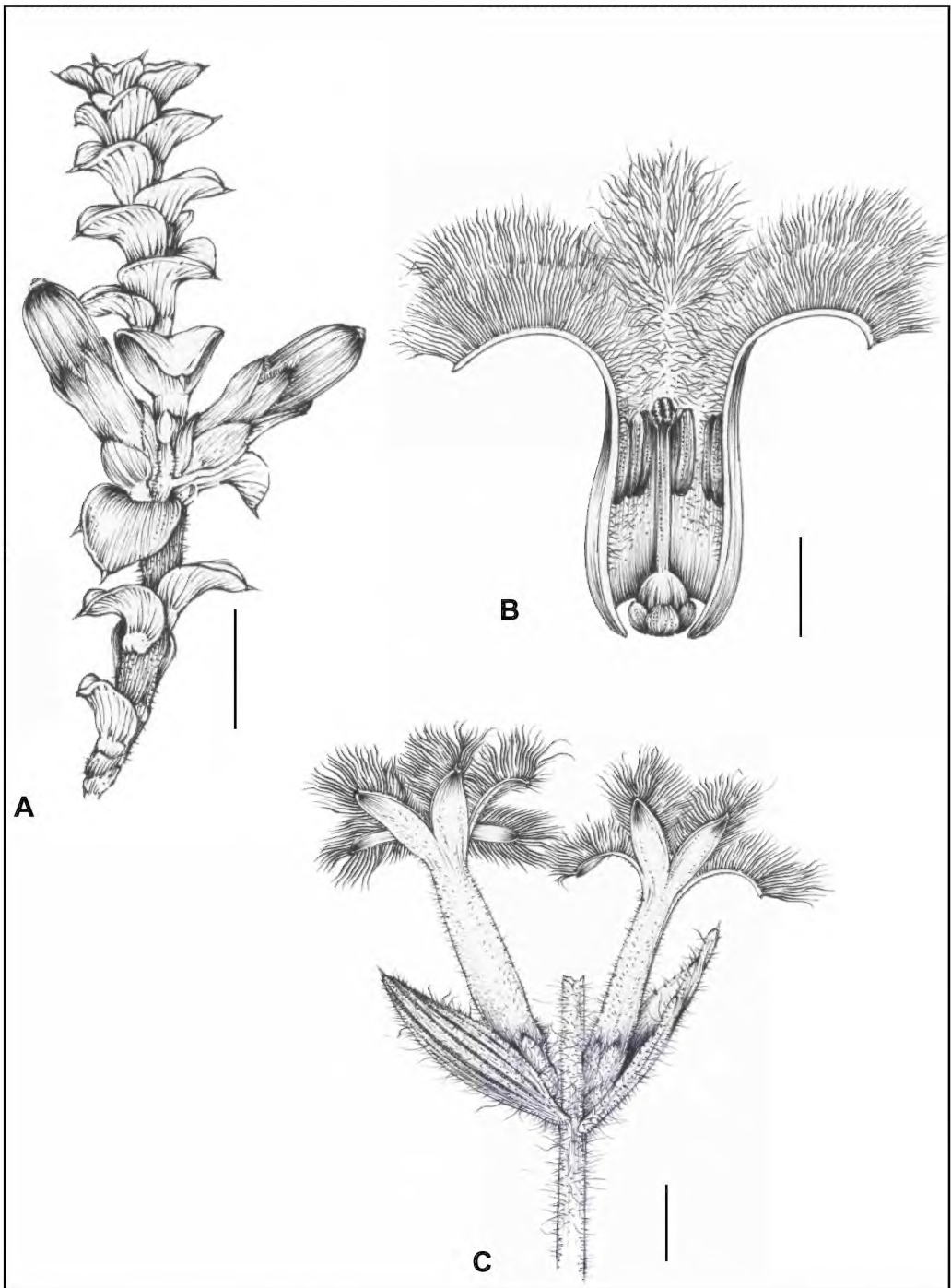


Figure 4. A – *Styphelia incerta*, flowering branchlet; B – *S. incerta*, flower, internal view; C – *S. pallida*, flowering branchlet. Scale bars A = 2 mm; B = 1 mm; C = 2 mm. Vouchers *A.M. Coates* 3377 (A), *M. Hislop* 4716 (B), *M. Hislop & R. Davis* MH 3344 (C). Drawings by Hung Ky Nguyen.

Affinities. *Styphelia incerta* is a distinctive species that is tentatively referred to the *S. tamminensis* subgroup in the absence of molecular data. It has the following critical morphological features that are strongly associated with that group: a cryptically 3-locular ovary; internal corolla tube hairs extending well down into the tube; included anthers; very short filaments inserted well down the corolla tube; corolla lobes spreading from the base; and corolla lobe hairs that are more or less straight and essentially unornamented. The most obviously anomalous feature though is a style that, while still included in the tube, is several times longer than any other species in the subgroup. And rather than having a style base that is not clearly differentiated from the acute ovary apex, in *S. incerta* the style is abruptly differentiated from an obtuse ovary apex. The only other species referred to the subgroup that shares the latter character is *S. exilis*, although its style is only 0.3–0.4 mm long.

Given its acute, longitudinally recurved leaves and relatively long style, it is unsurprising that many older collections of *S. incerta* were misidentified as the widespread and variable *S. hamulosa*. The latter species was not included in the phylogeny of Puente-Lelièvre *et al.* (2016) but critical features of its morphology give strong indication that it is a member of the well-supported subclade that includes *S. marginata* (W.Fitzg.) Hislop, Crayn & Puente-Lel. *Styphelia incerta* can be readily distinguished from all variants of *S. hamulosa* by its 3- rather than 5-locular ovary, included rather than exerted style, included rather than partially exerted anthers, hairy rather than glabrous internal corolla tube and always glabrous, rather than usually hairy, sepals.

As noted above there is a particular need for further molecular research into relationships within Group X and the placement of *S. incerta* should be confirmed as part of such a study.

Styphelia pallens* Hislop, *sp. nov.

Typus: Eneabba–Three Springs, Western Australia [precise locality withheld for conservation reasons], 9 November 2004, M. Hislop & R. Davis MH 3344 (*holo:* PERTH 07202881; *iso:* CANB, CNS, MEL, NSW 832202).

Leucopogon sp. Tathra (M. Hislop 2900), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 17 June 2022].

Low, spreading *shrub*, to c. 50 cm high and 50 cm wide, branching close to base of plant, with a fire-sensitive rootstock. Young *branchlets* with a moderately dense to dense indumentum of variously orientated, straight or curved hairs to c. 0.7 mm long. *Leaves* opposite, steeply antrorse to antrorse-appressed; apex mucronate, pungent or sub-pungent, the mucro usually \pm straight or sometimes distinctly recurved, 0.1–0.5 mm long; base attenuate to cuneate; petiole 0.2–0.6 mm long, usually hairy throughout or with the abaxial surface \pm glabrous; lamina usually narrowly ovate, occasionally narrowly elliptic, 3.0–7.5 mm long, 0.8–2.0 mm wide, \pm concolorous or with the abaxial surface slightly darker, strongly concave adaxially, longitudinal axis incurved; adaxial surface matt, with a moderately dense indumentum, venation not or barely evident; abaxial surface slightly shiny, with a sparse to moderately dense indumentum of spreading hairs (sometimes \pm glabrescent), with 5–7 primary veins, broadly and moderately to deeply grooved between the veins; margins ciliate with hairs to c. 1.0 mm long. *Inflorescence* axillary, erect; axis 0.3–0.5 mm long, 1(2)-flowered, hairy, apparently terminating in a flower, bud-rudiment absent; flowers erect, sessile. *Fertile bracts* elliptic or ovate, 0.3–0.5 mm long, 0.2–0.3 mm wide, with a larger sterile bract on the adaxial axis surface and 2 opposite, basal bracts on the same plane as the bracteoles. *Bracteoles* ovate, 1.0–1.5 mm long, 0.8–0.9 mm wide, not keeled, obtuse to subacute; abaxial surface with spreading hairs; margins ciliate. *Sepals* ovate to narrowly

ovate, 1.8–2.3 mm long, 0.8–1.0 mm wide, the apex obtuse to subacute, not recurved; abaxial surface with spreading hairs, pale green to straw-coloured, occasionally pinkish at apex, venation not evident; adaxial surface glabrous; margins ciliate with hairs to *c.* 0.4 mm long. *Corolla tube* pale yellow or cream, occasionally partially flushed red, appearing brownish on old flowers, cylindrical in upper portion, becoming \pm expanded in lower 1/3, much longer than the sepals, 4.0–6.0 mm long, 1.0–1.3 mm wide; the external surface of cylindrical portion moderately to densely hairy, the expanded basal portion glabrous; internal surface sparsely hairy in the cylindrical portion, glabrous in expanded basal portion, sometimes with poorly defined ring of retrorse hairs close the apex. *Corolla lobes* pale yellow or cream, sometimes partially flushed red, shorter than the tube, 1.4–2.0 mm long, 0.7–0.9 mm wide at base, spreading from the base and recurved, sparsely hairy externally, internal surfaces with a dense, white indumentum of terete, straight and unornamented hairs. *Anthers* fully included within the tube, 1.2–1.7 mm long, apex scarcely emarginate. *Filaments* \pm obsolete, <0.1 mm long, attached 1/2–2/3 above anther base, adnate at a point *c.* 2/3 the length of the tube above the base. *Nectary* partite, the scales 0.4–0.5 mm long, 0.2–0.3 mm wide, glabrous. *Ovary* very narrowly ovoid, 1.6–2.0 mm long, 0.4–0.5 mm wide, with a dense tuft of antrorse hairs at the base and scattered hairs above, pale green. *Style* not or scarcely differentiated from ovary apex in flower and early fruit, 0.1–0.2 mm long, included within the corolla tube; stigma usually appearing expanded and copiously covered in exudate. Mature fruit not seen. (Figure 4C)

Diagnostic characters. Within the *S. tamminensis* subgroup distinguished by the following character combination: leaves opposite, narrowly ovate or occasionally narrowly elliptic, with the longitudinal axis incurved; abaxial leaf surfaces moderately to deeply grooved between the veins; leaf apex mucronate, pungent or subpungent; inflorescence 1(2)-flowered; sepals hairy abaxially, margins ciliate; external corolla tube hairy, pale yellow or cream, occasionally partially flushed red; anthers fully included in the corolla tube; filaments attached to the anther just below anther apex, adnate to tube at a point *c.* 2/3 the length of the tube above the base; ovary hairy; style very short (0.1–0.2 mm long), scarcely differentiated from ovary apex in flower.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 18 Oct. 2003, *J. Borger* BB 193 (PERTH); 27 Oct. 2004, *J. Borger* BB 247 (PERTH); 5 Nov. 1992, *R. Cranfield & P. Spencer* 8421 (NSW, PERTH); 11 Nov. 1978, *E.A. Griffin* 1571 (PERTH); 10 Dec. 2001, *M. Hislop* 2508 (CANB, MEL, PERTH); 5 Dec. 2002, *M. Hislop* 2894 (K, PERTH); 5 Dec. 2002, *M. Hislop* 2895 (CANB, PERTH); 5 Dec. 2002, *M. Hislop* 2896 (PERTH); 6 Dec. 2002, *M. Hislop* 2900 (CANB, PERTH); 14 Nov. 2004, *M. Hislop & A. Tinker* MH 3357A (CANB, CNS, PERTH); 14 Nov. 2004, *M. Hislop & A. Tinker* MH 3357B (PERTH).

Distribution and habitat. Distributed to the east and north-east of Eneabba in the Geraldton Sandplains bioregion. Occurs in heathland communities, usually high in the landscape in sand or light loam over laterite. It has been recorded as growing in association with the following species: *Banksia carlinoides*, *Banksia lanata*, *Calothamnus sanguineus*, *Daviesia daphnoides*, *Allocasuarina humilis* and *Lambertia multiflora*.

Phenology. The main flowering period appears to be from the second half of October to early December. Mature fruit has not been seen but is likely to be present at least during the period between mid-summer and early winter.

Etymology. From Latin *pallens* (pale), a reference to the pale coloured corollas (pale yellow or cream, sometimes partially flushed red) relative to the other two species from the *S. tamminensis* alliance that

occur in the Geraldton Sandplains, *S. williamsiorum* and *S. hyalina*, which respectively have corollas that are dark purple or red throughout.

Conservation status. This species has a very restricted distribution but is locally common in one nature reserve and one national park. Recently listed as Priority Two under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Leucopogon* sp. Tathra (M. Hislop 2900).

Affinities. *Styphelia pallens* forms a well-supported sister relationship with *S. williamsiorum* (Punkte-Lelièvre *et al.* 2016; as *Leucopogon* sp. Tathra and *L.* sp. Warradarge respectively), and indeed this correlates with a close similarity in their morphology. Both species have corolla tubes that are hairy on their external surfaces, an ovary with a basal hair tuft, and filaments that are adnate to the corolla tube well below the throat. Corolla colour is the most obvious difference between the two: pale yellow or cream, sometimes partially flushed red in *S. pallens*, compared to uniformly dark purple in *S. williamsiorum*. The abaxial leaf surfaces of *S. pallens* are moderately to deeply grooved between the veins whereas in *S. williamsiorum* they are flat to shallowly grooved. Other distinguishing features are to be found in the sepals: *S. pallens* has spreading hairs on the abaxial surfaces and the apices are not recurved, whereas in *S. williamsiorum* the abaxial surfaces are glabrous or very occasionally with a few antrorse hairs and the apices are usually recurved. Other more subtle differences include the strong tendency for *S. pallens* to have longer branchlet hairs (to c. 0.7 mm long *cf.* to c. 0.3 mm in *S. williamsiorum*) and longer sepal cilia (to c. 0.4 mm long *cf.* to c. 0.2 mm). The two species have allopatric distributions, with *S. pallens* occurring to the north-east of *S. williamsiorum*.

To the north of the distribution of *S. pallens* occurs another member of the *S. tamminensis* subgroup, *S. hyalina*. These two species are easily distinguished, as outlined in the treatment of the latter.

Styphelia papillosa* Hislop, *sp. nov.

Typus: north-east of Arthur River, Western Australia [precise locality withheld for conservation reasons], 13 February 2004, M. Hislop 3161 A (*holo:* PERTH 06756646; *iso:* CANB, CNS, HO, K, MEL, NSW 832180).

Leucopogon sp. Dongolocking (K. Kershaw KK 2333), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 17 June 2022].

Erect, spreading *shrub* to c. 50 cm high and 50 cm wide, single-stemmed at ground level, with a fire-sensitive rootstock. Young *branchlets* with a sparse to moderately dense indumentum of patent to retrorse hairs to c. 0.2 mm long. *Leaves* helically arranged, variously antrorse, usually steeply so; apex mucronate, pungent, the mucro \pm straight to slightly inflexed, 0.2–0.6 mm long; base cuneate to attenuate; petiole 0.3–0.5 mm long, \pm glabrous or sparsely hairy on abaxial surface and margins; lamina narrowly to broadly ovate, 3.0–15 mm long, 1.4–3.0 mm wide, slightly discoloured, strongly concave adaxially, longitudinal axis distinctly incurved; adaxial surface \pm matt, usually sparsely hairy in the lower half or \pm glabrous, sometimes distinctly hairy throughout, venation not evident; abaxial surface paler, shiny, glabrous or sometimes moderately to densely hairy throughout, with 7–9 primary veins, the midvein rather broader than the others, shallowly to deeply grooved between the veins; margins minutely hairy with short, stiff, antrorse hairs <0.1 mm long or \pm glabrous. *Inflorescence* axillary, erect; axis 1.5–4.3 mm long, 1–5-flowered, subterete below the lowest fertile bract, the remainder bluntly to sharply angular, with a moderately dense indumentum of short hairs, terminating in a bud-rudiment;

flowers erect, sessile. *Fertile bracts* broadly ovate, 0.6–1.0 mm long, 0.6–0.9 mm wide, subtended by 3 sterile bracts, the basal 2 opposite. *Bracteoles* usually broadly ovate to broadly elliptic, occasionally ovate, 1.0–1.4 mm long, 0.8–1.1 mm wide, keeled, sometimes obscurely so, obtuse to subacute; abaxial surface glabrous; margins ciliolate. *Sepals* ovate to narrowly ovate, 2.0–2.7 mm long, 0.8–1.1 mm wide, obtuse or occasionally subacute, the apex appressed; abaxial surface glabrous or sometimes variably hairy, pale green to straw-coloured, sometimes with pink tinges, only the rather obscure mid-vein evident; adaxial surface usually glabrous, occasionally with a few hairs towards the apex; margins ciliolate with hairs to 0.1 mm long. *Corolla tube* white, narrowly ellipsoid, narrowly ovoid or \pm cylindrical, usually longer than or sometimes equal to the sepals, 1.7–2.5 mm long, 0.9–1.2 mm wide, glabrous externally and faintly papillose in the upper half, internal surface with an apical band of hairs in the upper 1/4 that extends below the anther bases, the remainder glabrous. *Corolla lobes* white or pale pink, shorter than the tube, 1.0–1.5 mm long, 0.5–0.6 mm wide at base, spreading from close to the base and recurved, glabrous externally, sometimes papillose at the base, internal surface with a dense indumentum of terete, \pm straight and essentially unornamented hairs, the basal hairs reflexed and forming a dense tuft which extends well into the tube. *Anthers* fully included within the tube, 0.4–0.7 mm long, apex rounded to scarcely emarginate. *Filaments* terete, c. 0.1 mm long, attached to the anther just below the apex, adnate to tube well below the sinuses (from a little below to a little above 3/4 the length of the tube above the base). *Nectary* partite, the scales 0.3–0.5 mm long, 0.2–0.3 mm wide, glabrous, papillose. *Ovary* narrowly ellipsoid, 0.8–1.0 mm long, 0.4–0.5 mm wide, glabrous, papillose in the upper portion, 3(4)-locular, pale green or straw-coloured. *Style* smoothly attenuated from the ovary apex but clearly differentiated, 0.1–0.2 mm long, papillose, included within the corolla tube; stigma not or scarcely expanded. *Fruit* \pm cylindrical or fusiform, 3.3–3.8 mm long (inclusive of gynophore), 0.9–1.1 mm wide, much longer than the sepals, circular in section, with a well-defined gynophore; surface glabrous, papillose, \pm dry, smooth (mesocarp poorly developed), with pale longitudinal ribs; apex acute, tapering smoothly to the base of the persistent style. (Figure 5A, B)

Diagnostic characters. Within the *S. tamminensis* subgroup distinguished by the following character combination: leaves helically arranged, narrowly to broadly ovate, with the longitudinal axis distinctly incurved; abaxial leaf surfaces variable, shallowly to deeply grooved between the veins, usually glabrous or occasionally densely hairy; adaxial surfaces \pm glabrous to distinctly hairy; leaf apex mucronate, pungent; sepals obtuse or occasionally subacute (apices appressed), usually glabrous or occasionally hairy; anthers short (0.4–0.7 mm long) fully included within the corolla tube; filaments attached to anther just below anther apex, adnate to tube \pm 3/4 the length of the tube above the base; ovary glabrous, papillose in the upper portion; style very short (0.1–0.2 mm long), but still clearly differentiated from the ovary apex; fruit \pm dry, \pm cylindrical or fusiform, with an acute apex.

Other specimens examined. WESTERN AUSTRALIA: Apr. 1985, *D. Backshall* s.n. (PERTH); 2 Oct. 1999, *A.G. Gunness et al.* RICH 2/32 (PERTH); 25 May 2004, *M. Hislop & F. Hort* MH 3240 (CANB, CNS, PERTH); 21 Dec. 2014, *M. Hislop* 4382 (PERTH); 29 Apr. 2015, *M. Hislop* 4417A (CNS, PERTH); 12 Jan. 1978, *R. Hnatiuk* 780015 (PERTH); 1 May 1999, *G.J. Keighery & N. Gibson* 5565 (PERTH); 15 Apr. 2002, *K. Kershaw* KK 2333 (CANB, CNS, MEL, PERTH); 15 Apr. 2002, *K. Kershaw* KK 2335 (PERTH); 15 Apr. 2002, *K. Kershaw* KK 2338 (CNS, MEL, NSW, PERTH); 15 Apr. 2002, *K. Kershaw* KK 2339 (CANB, CNS, PERTH); 2 Apr. 2003, *K. Kershaw* KK 2385 (MEL, PERTH); 2 Apr. 2003, *K. Kershaw* KK 2387 (PERTH); 19 June 1999, *L.W. Sage & F. Obbens* LWS 1495 (NSW, PERTH).

Distribution and habitat. Sporadically distributed from near Wickpin south to the Woodanilling area, and from north-west of Wagin eastwards to Tarin Rock; in the south of the Avon Wheatbelt and far

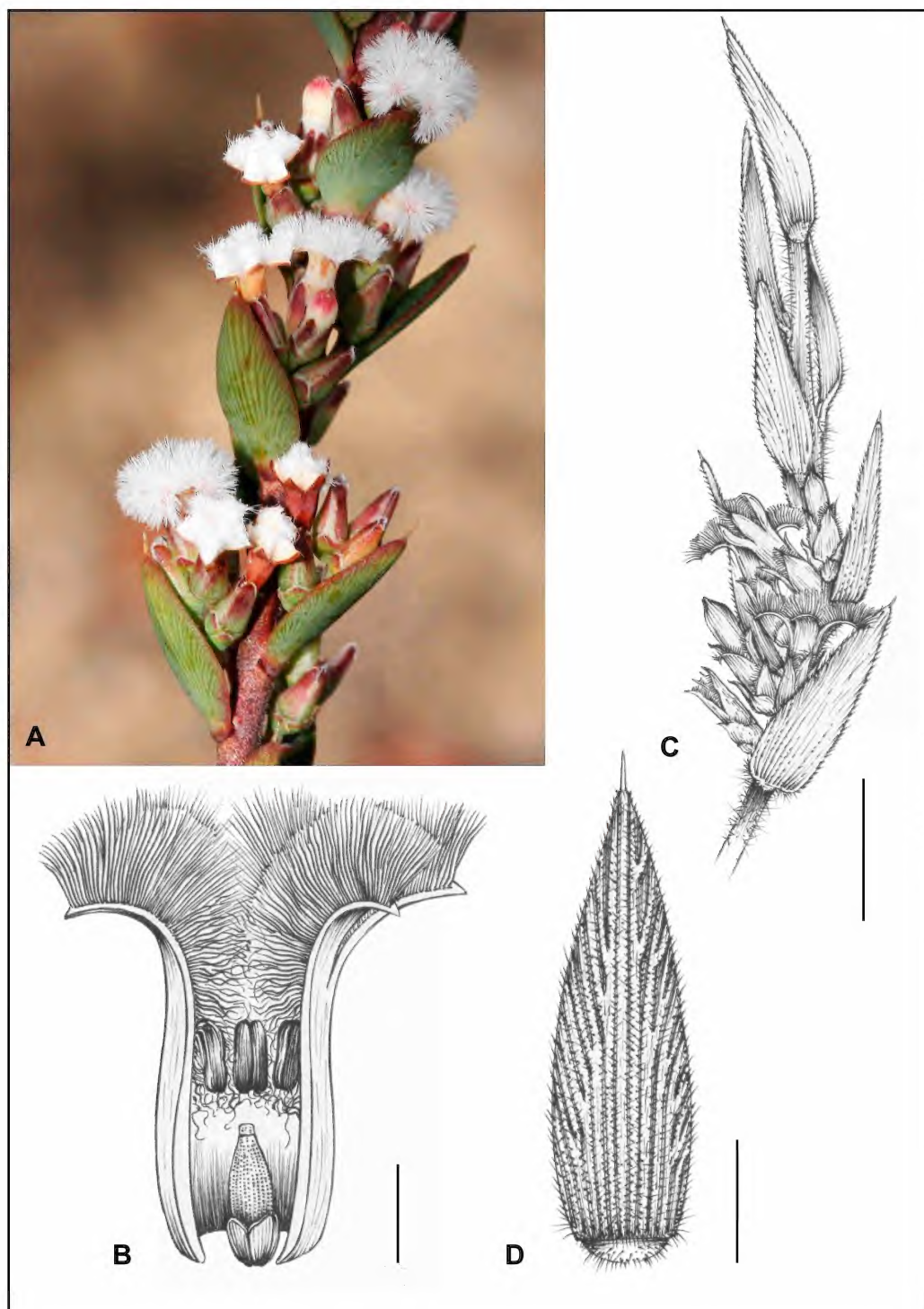


Figure 5. A – *Styphelia papillosa*, flowering branchlet *in situ*; B – *S. papillosa*, flower, internal view; C – *S. recurva*, flowering branchlet; D – *S. recurva*, leaf, abaxial surface. Scale bars B = 1 mm; C = 5 mm; D = 2 mm. Vouchers M. Hislop 3161 A (B), F. Hort 915 (C, D). Photograph by Jolanda Keeble (unvouchered). Drawings by Hung Ky Nguyen.

west of the Mallee bioregions. Grows in heath or open mallee woodland, in sandy soils, usually over laterite. Commonly associated species include *Eucalyptus dorrienii*, *Banksia armata*, *B. sphaerocarpa*, *Gastrolobium spinosum*, *Petrophile divaricata* and *Melaleuca pungens*.

Phenology. Most flowering collections have been made in the period from late spring to late autumn. Mature fruit has been collected in April and June but given the lengthy flowering period is likely to be present over many months of the year.

Etymology. From the Latin *papillosus* (bearing many small, nipple-like projections), a reference to papillose surfaces of the gynoecium.

Conservation status. Has a fairly restricted and scattered distribution in the southern wheatbelt but most of the known occurrences are from nature reserves. Recently listed as Priority Three under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Leucopogon* sp. Dongolocking (K. Kershaw KK 2333).

Affinities. *Styphelia papillosa* is probably closest morphologically to *S. cymbiformis* and *S. recurva* (the former distributed to the south of *S. papillosa* and the latter to the north) and it is with those species that it is most likely to be confused. In comparison to *S. cymbiformis*, *S. papillosa* has smaller anthers (0.4–0.7 mm long *cf.* at least 1.1 mm in *S. cymbiformis*), filaments that are attached to the corolla tube further down the corolla tube (about 3/4 the length of the tube above the base *cf.* at or a little below the corolla lobe sinuses), and a more clearly defined style. It also has leaves with mucronate, pungent apices (*cf.* usually obtuse or if acute then non-mucronate, with a pungent mucro evident in only one gathering) and a less obvious abaxial midvein (*cf.* prominent and keel-like).

Differences between *S. papillosa* and *S. recurva* are given under the treatment of the latter species.

Notes. *Styphelia papillosa* varies in the degree to which the abaxial leaf surfaces are grooved and in the presence of hairs on the leaves and sepals. While most collections have glabrous leaf surfaces and sepals, a few are moderately to densely hairy on those parts. Two examples from different parts of the species' range indicate that this variation even occurs within populations (K. Kershaw KK 2333 & KK 2333A; M. Hislop 4417A & 4417B).

Styphelia platyneura* Hislop, *sp. nov.

Typus: south of Forrestania, Western Australia [precise locality withheld for conservation reasons], 8 August 2000, M. Hislop 2107 (*holo:* PERTH 05642256; *iso:* CANB, CNS, HO, K, MEL, NSW).

Leucopogon sp. Ironcaps (N. Gibson & K. Brown 3070) *p.p.*, Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 17 June 2022].

Erect, open to ± compact *shrub* to c. 100 cm high and 60 cm wide, single-stemmed at ground level, with a fire-sensitive rootstock. Young *branchlets* with a moderately dense indumentum of patent to retrorse hairs to c. 0.1 mm long. *Leaves* helically arranged, antrorse; apex mostly obtuse or subacute, occasionally acute; base cuneate to rounded; petiole 0.2–0.5 mm long, glabrous throughout or with a few hairs at the base of the abaxial surface; lamina obovate to ovate or broadly so, 1.3–2.0 mm long,

1.0–1.6 mm wide, \pm concolorous, thick, concave adaxially or sometimes \pm planoconvex, sometimes \pm stem-clasping in the lower half, longitudinal axis \pm straight to distinctly recurved; adaxial surface shiny, hairy in the lower half, glabrous above, venation not evident; abaxial surface shiny, glabrous throughout or often with very short, stiff hairs on the veins, with 5–7 broad, primary veins, the midvein rather broader than the others, deeply and openly grooved between the veins; margins minutely hairy with short, stiff, antrorse hairs <0.05 mm long. *Inflorescence* axillary, erect; axis 1.3–1.8 mm long, 1- or 2-flowered, subterete below the lowest fertile bract, compressed above the uppermost, with a moderately dense indumentum, terminating in a bud-rudiment; flowers erect, sessile. *Fertile bracts* ovate, 0.8–1.4 mm long, 0.7–0.9 mm wide, subtended by 3 sterile bracts, the basal 2 opposite. *Bracteoles* ovate, 1.3–1.7 mm long, 1.0–1.2 mm wide, keeled, obtuse to subacute; abaxial surface shortly hairy at least in the upper half; margins ciliate with longer hairs towards the apex. *Sepals* narrowly ovate, 2.0–2.5 mm long, 1.0–1.2 mm wide, subacute to acute; abaxial surface shortly hairy at least in the upper half, mostly green but often becoming pink towards the apex and margins, only the rather obscure mid-vein evident; adaxial surface with hairs towards the apex and usually a discrete hair tuft at the base; margins ciliate with hairs to *c.* 0.3 mm long, the longest towards the apex. *Corolla tube* white, narrowly ellipsoid, narrowly obovoid to \pm cylindrical, a little longer than the sepals, 1.8–2.4 mm long, 1.0–1.4(1.6) mm wide, glabrous externally, internal surface hairy towards the apex with hairs projecting downwards to a point level with the middle of the anthers or lower, glabrous below. *Corolla lobes* white, shorter than the tube, 1.3–1.5 mm long, 0.5–0.7 mm wide at base, spreading from close to the base and recurved, glabrous externally, internal surface with a dense indumentum of terete, \pm straight and essentially unornamented hairs. *Anthers* fully included within the tube (the tips \pm held at the orifice), 1.1–1.5 mm long, apex scarcely emarginate, \pm recurved. *Filaments* terete, 0.1–0.2 mm long, attached to anther \pm at or just below the apex, adnate to tube just or sometimes distinctly below the sinuses. *Nectary* partite, the scales 0.3–0.4 mm long, 0.2–0.3 mm wide (possibly occasionally weakly cohering), glabrous. *Ovary* narrowly ovate, 1.0–1.1 mm long, 0.4–0.5 mm wide, glabrous, 3-locular, pale green or yellow-green. *Style* smoothly attenuated from (and with the base not clearly differentiated from) the ovary apex, 0.3–0.4 mm long, papillose, included within the corolla tube; stigma not or scarcely expanded. *Fruit* \pm cylindrical, fusiform or very narrowly ovoid, sometimes curved, 3.0–3.5 mm long (inclusive of gynophore), 1.0–1.3 mm wide, much longer than the sepals, circular in section, with a well-defined gynophore; surface glabrous, \pm dry, smooth (mesocarp poorly developed), with pale, longitudinal ribs; apex acute, tapering smoothly to the style base; style persistent or not. (Figure 6)

Diagnostic characters. Within the *S. tamminensis* subgroup distinguished by the following character combination: leaves helically arranged, obovate to ovate, or broadly so with the longitudinal axis straight to distinctly recurved; abaxial leaf surfaces with deep, open grooves between the veins, often shortly hairy on the vein surfaces, glabrous within the grooves; leaf apex innocuous, non-mucronate; inflorescence 1- or 2-flowered; sepals and bracteoles shortly hairy abaxially, at least in the upper half; anther tips included within corolla tube; filaments attached to anther at or just below anther apex, adnate to tube just below (or sometimes distinctly below) the sinuses; ovary glabrous; style 0.3–0.4 mm long; fruit \pm dry, \pm cylindrical, fusiform or very narrowly ovoid, with an acute apex.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 3 Aug. 2005, G.F. Craig 6709 (PERTH); 7 Sep. 1996, N. Gibson & K. Brown 2519 (PERTH); 7 Sep. 1996, N. Gibson & K. Brown 3070 (PERTH); 5 Sep. 1996, N. Gibson & K. Brown 3071 (PERTH); 9 Aug. 2000, M. Hislop 2111 (CNS, PERTH); 12 Nov. 2001, M. Hislop 2458 (CANB, MEL, NSW, PERTH); 12 Nov. 2001, M. Hislop 2460 (CNS, PERTH); 21 Aug. 2001, K. Kershaw & M. Golding KK 2269 (CANB, CNS, K, MEL, PERTH); 4 Sep. 1970, K.R. Newbey 3285 (PERTH).



Figure 6. *Styphelia platyneura*. A – flowering plant *in situ*; B – fruiting branchlet. Scale bar B = 3 mm. Vouchers *M. Hislop* 2107 (A), *M. Hislop* 2111 (B). Photograph by Michael Hislop. Drawing by Hung Ky Nguyen.

Distribution and habitat. Distributed from the Forrestania district south and east to the eastern part of Frank Hann National Park, in the central Mallee bioregion. Grows in sand or sandy loam soils usually over laterite or ironstone, on undulating plain or sometimes ironstone hills. Associated vegetation is open mallee woodland or heath with the following among the species with which it has been commonly recorded: *Eucalyptus tenera*, *Hakea scoparia*, *Banksia elderiana*, *Melaleuca cordata*, *M. pungens*, *Allocasuarina campestris* and *A. acutivalvis*.

Phenology. Appears to flower sporadically over many months of the year. Most flowering collections also have fruit present at various stages of maturity. Those specimens collected in November have the largest numbers of buds and flowers present, which may indicate that late spring and early summer is the peak flowering period.

Etymology. From the Greek *platys* (flat, wide) and *-neurus* (-nerved), a reference to the broad midvein of the abaxial leaf surface.

Conservation status. *Styphelia platyneura* will be listed as Priority Two under Conservation Codes for Western Australian Flora (T. Llorens pers. comm.).

Affinities. The species most likely to be confused with *S. platyneura* is *S. subglauc*, which also has innocuous, non-mucronate leaf apices. Differences between the two are given under the treatment of the latter species.

Styphelia echinulata is another somewhat similar species, although growing well to the north of the known distribution of *S. platyneura*. In addition to having pungent, mucronate leaf apices, *S. echinulata* differs in its much narrower, \pm closed and hairy abaxial leaf grooves. The floral parts of *S. echinulata* are also generally smaller: sepals 1.4–2.0 mm long (cf. 2.0–2.5 mm in *S. platyneura*), anthers 0.6–1.0 mm long (cf. 1.1–1.5 mm) and style c. 0.2 mm long (cf. 0.3–0.4 mm).

Styphelia pogonocalyx (Benth.) F. Muell., *Syst. Census Austral. Pl.* 107 (1882); *Leucopogon pogonocalyx* Benth., *Fl. Austral.* 4: 222 (1868). Type: ‘W. Australia. Mount Manypeak’, s. dat., G. Maxwell s.n. (syn: K 000347896 image!, L 0006569 image!, MEL 1512190 image!).

Leucopogon sp. Mondurup (K.F. Kenneally 11445), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [before October 2005].

Distribution. All PERTH collections of this species are from the Stirling Range National Park or the immediately surrounding country, in the far west of the Esperance Plains and adjacent southern Jarrah bioregions. No subsequent collections have apparently been made from the type locality of Mount Manypeaks.

Conservation status. Currently listed as Priority Four under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–). *Styphelia pogonocalyx* is locally common in the Stirling Range National Park but if, like many epacrids, it is susceptible to the root-rot pathogen *Phytophthora cinnamomi*, which now affects much of the park, it is likely to suffer significant future decline.

Styphelia recurva* Hislop, *sp. nov.

Typus: Watershed Road, Geddes State Forest, Wandering; 0.7 km south of Ref Tree BW 84/1, at pine plot then 200 m north-west, Western Australia, 1 February 2000, *F. Hort* 915 (*holo*: PERTH 05510740; *iso*: CANB, CNS, MEL).

Leucopogon sp. Wandering (F. Hort 419), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 17 June 2022].

Erect or sprawling *shrub* to *c.* 80 cm high and 90 cm wide, single-stemmed at ground level, with a fire-sensitive rootstock. Young *branchlets* with a moderately dense to dense indumentum of mostly patent hairs to *c.* 0.5 mm long. *Leaves* helically arranged, variously antrorse, usually steeply so; apex usually long-mucronate, pungent, the mucro \pm straight to slightly inflexed, 0.2–1.0 mm long; petiole 0.3–0.6 mm long, hairy throughout or sometimes \pm glabrous; lamina usually narrowly ovate, sometimes ovate or broadly ovate, 3.0–11 mm long, 1.3–3.4(4.0) mm wide, distinctly discolorous, concave adaxially or sometimes flat to convex, longitudinal axis strongly incurved to gently recurved; adaxial surface shiny, sparsely to moderately hairy, at least in the lower half, occasionally glabrous, venation not evident; abaxial surface paler, matt to slightly shiny, moderately to densely hairy, less often glabrous, with 5–9 primary veins, the midvein scarcely broader than the others, moderately to deeply grooved between the veins; margins usually variably ciliate with hairs to *c.* 0.5 mm long, occasionally glabrous. *Inflorescence* axillary, erect; axis 1.0–5.2 mm long, 1–6-flowered, subterete below the lowest fertile bract, the remainder \pm angular, with a moderately dense to dense indumentum, terminating in a bud-rudiment; flowers erect, sessile. *Fertile bracts* ovate to broadly ovate, 0.8–1.5 mm long, 0.7–0.8 mm wide, subtended by 3 or 4(5) sterile bracts, the basal 2 opposite. *Bracteoles* ovate, 1.2–2.0 mm long, 0.8–1.0 mm wide, keeled, sometimes rather obscurely so, acute and usually acuminate; abaxial surface hairy with a sparse to moderately dense indumentum, sometimes glabrous; margins ciliate. *Sepals* narrowly ovate, 2.2–3.3 mm long, 0.9–1.1 mm wide, acuminate, the apex filiform, usually \pm recurved, occasionally almost straight (but not appressed); abaxial surface usually hairy with a sparse to dense indumentum of spreading hairs, sometimes glabrous, pale green to straw-coloured, only the rather obscure mid-vein evident; adaxial surface sparsely hairy towards the apex and often also at the base; margins ciliate with hairs to 0.3 mm long. *Corolla tube* white, narrowly ellipsoid, usually shorter than, but occasionally slightly longer than, the sepals, (1.5)2.0–2.8 mm long, 0.8–1.3 mm wide, glabrous externally and papillose in the upper half, internal surface with an apical band of hairs in the upper 1/4 that extend below the anther bases, the remainder glabrous. *Corolla lobes* white, shorter than the tube, (1.3)1.5–2.1 mm long, 0.5–0.6 mm wide at base, erect for *c.* 1/3 of their length and then spreading and recurved, glabrous and papillose externally, internal surface with a dense indumentum of terete, \pm straight and essentially unornamented hairs, the basal hairs reflexed. *Anthers* usually partially exerted from the tube by 1/8–1/4 of their length (occasionally included with the tips held at the orifice), (0.6)0.7–1.0 mm long, apex scarcely emarginate. *Filaments* terete, 0.1–0.2 mm long, attached to the anther 3/4–7/8 above base, adnate to tube just below sinuses. *Nectary* partite, the scales 0.3–0.5 mm long, 0.2–0.3 mm wide, glabrous. *Ovary* narrowly ellipsoid to fusiform, 0.8–1.1 mm long, 0.3–0.5 mm wide, glabrous, papillose in the upper portion. 3-locular, pale green or straw-coloured. *Style* smoothly attenuated from the ovary apex but clearly differentiated, 0.1–0.2 mm long, papillose, stigma scarcely expanded. Mature *fruit* not seen, immature fruit \pm cylindrical, papillose. (Figure 5C, D)

Diagnostic characters. Within the *S. tamminensis* subgroup distinguished by the following character combination: leaves helically arranged, narrowly to broadly ovate, with the longitudinal axis strongly incurved to gently recurved; abaxial leaf surfaces moderately to deeply grooved between the veins, usually hairy, or occasionally glabrous; adaxial leaf surfaces usually sparsely to moderately hairy or

occasionally glabrous; leaf apex long-mucronate, pungent; sepals acuminate (apices usually recurved, occasionally \pm straight), usually hairy or occasionally glabrous; anthers usually partially exerted from the corolla tube, occasionally included with the tips held at the orifice; filaments attached to anther 3/4–7/8 above base, adnate to tube just below sinuses; ovary glabrous, papillose in the upper portion; style very short (0.1–0.2 mm long) but clearly differentiated from ovary apex.

Other specimens examined. WESTERNAUSTRALIA: firebreak at W boundary of N block of Birdwhistle Nature Reserve, NE of Narrogin, 9 Mar. 2002, *M. Hislop* 2547 (CANB, CNS, PERTH); firebreak at S boundary of N block of Birdwhistle Nature Reserve, NE of Narrogin, 9 Mar. 2002, *M. Hislop* 2548 (CNS, PERTH); Boyagin Nature Reserve, W block N of Boyagin Rd, off N–S firebreak c. 1 km N of southern boundary, 20 June 2004, *M. Hislop* 3253 (PERTH); Bouncer Rd, Shire of York, Flynn FB: from Ref Tree AS 85/1 on Bouncer Rd continue E for 200 m then track to shrubland 250 m NNE, 3 Feb. 1999, *F. Hort* 419 (CNS, PERTH); Little Darkin Swamp, Flynn State Forest, Warrigal Rd: 2.4 km N of the NE corner of the swamp, 20 Jan. 2000, *F. Hort* 909 (CANB, MEL, NSW, PERTH); Randall Rd, Geddes State Forest [N of North Bannister], 300 m W of junction with Watershed Rd, then S for 60 m, 1 Feb. 2000, *F. Hort* 916 (CANB, NSW, PERTH); c. 300 m W of junction of Watershed Rd and Schulstaad Rd, Geddes State Forest [N of North Bannister], 1 Feb. 2000, *F. Hort* 917 (PERTH); Watershed Rd, Brady State Forest [N of North Bannister], 6.9 km S of Brookton Hwy, then 300 m W, 3 Feb. 2000, *F. Hort* 920 (NSW, PERTH); Metro Rd, Gibbs State Forest, Wandering: 4.6 km S of Division Track, then 1.2 km to the ESE, 18 Jan. 2001, *F. Hort* 1265 (PERTH); Division Track, Gibbs State Forest, Wandering: 3.5 km E of Metro Rd, then 1.6 km N, 23 Jan. 2001, *F. Hort* 1266 (CNS, K, PERTH); Flynn Forest Block [SW of York], Bouncer Rd 2.2 km S of Ridley Rd, then 200 m E, 30 Mar. 1999, *F. & J. Hort* 450 (PERTH); Wearne State Forest, Barrett Rd [N of Wandering]: 300 m S of Ref. Tree CD 95/1 (at junction of Strange Rd), then c. 150 m W, 5 Mar. 2001, *F. & J. Hort* 1278 (PERTH); Lupton Conservation Park, Ricks Rd [E of North Bannister], 1.25 km E of Heartbreak Rd, then 300 m N, 20 May 2010, *F. & J. Hort* 3634 (CNS, MEL, PERTH); Nockine State Forest, Yarra Rd, W side of road, c. 100 m S from Deefor Rd [SW of York], 31 Jan. 2016, *F. & J. Hort* FH 4003 (CANB, K, PERTH); Dale West Rd, Wandoo Conservation Park, 19.9 km from Brookton Hwy, then 50 m N [E of Armadale], 6 Feb. 2000, *F. Hort*, *J. Hort* & *M. Hislop* 925 (CNS, MEL, PERTH); Deefor Rd, Flynn State Forest [SW of York]: 5.7 km E of Yarra Rd, 18 Jan. 2000, *F. Hort*, *J. Hort* & *A. Lowrie* 908 (CNS, NSW, PERTH); Monadnocks Conservation Park, Watershed Rd, 2.08 km directly NNE at 214 degrees from Pike Rd junction, W of road, 24 Mar. 2010, *F. Hort* & *M. Pasotti* 3632 (CANB, MEL, PERTH); Candy Block, Dryandra [State Forest], 26 km N of Narrogin, 7 July 1987, *G.J. Keighery* 9987 (CANB, CNS, PERTH); Boundain Nature Reserve, 21067 & 17115 [E of Narrogin], on track and along edge of track through centre of reserve, 27 July 2000, *K. Kershaw* 2119 (PERTH); 4.9 km W of Wandering–Narrogin Rd on Colac Rd, Dryandra State Forest, c. 20 km NW of Narrogin, 15 Jan. 1996, *T.R. Lally* & *B.J. Lepschi* TRL 935 (PERTH); Narrakine Block, Highbury Forestry [W of Highbury], 8 Feb. 2000, *G. Warren*, *K. Kershaw* & *G. Hansen* 126B (NSW, PERTH).

Distribution and habitat. Occurs mostly in the Darling Range from Wandoo National Park, west of York, to the Narrogin district; in the Jarrah Forest and western Avon Wheatbelt bioregions. Grows in sand or light loam soils over laterite or less often granite, in woodland or heath. Among the more commonly associated species are *Eucalyptus marginata*, *Corymbia calophylla*, *Hakea undulata*, *H. trifurcata*, *Banksia armata*, *Allocasuarina humilis*, *Melaleuca aspalathoides* and *Leptospermum erubescens*.

Phenology. The species is in full flower at the hottest time of the year, between January and March, but with some flowering continuing into late autumn and early winter. Given that this is a relatively well-collected species, it is remarkable that mature fruit has not been observed; these are likely to be present from late winter through the spring months.

Etymology. From the Latin *recurvus* (bent backwards), a reference to the usually recurved sepal tips.

Conservation status. *Styphelia recurva* occurs on a number of reserves and in state forest across its range and is often locally common. No conservation code applies.

Affinities. Of the three other members of the *S. tamminensis* subgroup that occur in the Darling Range north and south of Perth, both *S. bracteolosa* and *S. roseola* differ from *S. recurva* in having opposite and decussate rather than spirally arranged leaves. The third, *S. annulata*, is readily distinguished by its basal ring of ovarian hairs (*cf.* ovary glabrous in *S. recurva*) and sepals with straight, thickened, and contrasting green tips (*cf.* more or less uniformly coloured sepals with usually recurved tips).

Morphological similarity would suggest the closest relative of *S. recurva* is likely to be *S. papillosa*. In the context of the *S. tamminensis* subgroup, the two share the distinctive characters of a papillose ovary and a style that, while very short, is clearly differentiated from the ovary. Their distributions overlap slightly at the southern extent of the geographic range of *S. recurva* and, although there are no records of the two co-occurring, they are known to grow within 30 km of each other. A sepal character is the most obvious difference between the two: the tips of the sepals are attenuate and usually recurved in *S. recurva* but obtuse or occasionally subacute and appressed to the corolla tube in *S. papillosa*. The point of stamen attachment to the corolla and anther length are also important differences. Whereas in *S. recurva* the filaments are attached to the corolla tube just below the sinuses and the anthers are (0.6)0.7–1.0 mm long, in *S. papillosa* the point of filament attachment is well below the sinuses (*c.* 3/4 the length of the tube above the base) and the anthers are 0.4–0.7 mm long. Other differences are the noticeably longer sepal cilia of *S. recurva* (to 0.3 mm long, *cf.* to 0.1 mm in *S. papillosa*) and the longer corolla lobes ((1.3)1.5–2.1 mm long *cf.* 1.0–1.5 mm).

There is a tendency for the southern populations of *S. recurva* to have relatively shorter and broader leaves with a more uniformly short indumentum on their abaxial surfaces. Across most of the species range the abaxial leaf surfaces usually have a mixture of long and short hairs, but occasional glabrous forms occur. The presence of hairy and glabrous leaf forms is another feature that *S. recurva* has in common with *S. papillosa*, but interestingly while the hairy form predominates in the former, the glabrous form is far more common in the latter.

Styphelia roseola* Hislop, *sp. nov.

Typus: Anvil block, Julimar State Forest, south-west of Bolgart, Western Australia, 25 November 2001, M. Hislop & F. Hort MH 2486 (*holo:* PERTH 05918502; *iso:* CANB, MEL, NSW).

Leucopogon sp. Bolgart (M. Hislop & F. Hort MH 2486), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 17 June 2022].

Spreading *shrub*, to *c.* 70 cm high and 100 cm wide but often much smaller, multi-stemmed from close to base of plant, with a fire-sensitive rootstock. Young *branchlets* with a sparse to moderately dense indumentum of patent to retrorse, straight or curved hairs to *c.* 0.3 mm long. *Leaves* opposite, steeply antorse to antorse-appressed; apex mucronate, pungent, the mucro straight, 0.2–0.5 mm long; base cuneate or occasionally \pm attenuate; petiole 0.2–0.5 mm long, variously hairy or glabrous; lamina narrowly ovate to narrowly elliptic, 3.5–7.0 mm long, 1.0–2.1 mm wide, \pm concolorous, usually concave adaxially, but sometimes flat or convex towards the base, longitudinal axis distinctly incurved; adaxial surface slightly shiny, hairy, usually throughout but sometimes only at the base,

venation usually evident with 1–5 slightly raised veins; abaxial surface slightly shiny, usually variously hairy (especially in the grooves), occasionally glabrous, with 5–7 primary veins, the midrib distinctly broader than the others, grooves between the veins varying from broad and shallow to narrow and deep; margins usually irregularly ciliate with stiff hairs to 0.2 mm long, occasionally glabrous. *Inflorescence* axillary, erect; axis 0.3–0.8 mm long, usually 1- or rarely 2-flowered, hairy, terminating in a short, bract-like point (usually obscured by the fertile bract); flowers erect, sessile. *Fertile bracts* ovate to depressed-ovate, 0.3–0.7 mm long, 0.3–0.5 mm wide, with a larger sterile bract opposite (i.e. on the adaxial axis surface) and 2 opposite, basal bracts on the same plane as the bracteoles. *Bracteoles* ovate or broadly ovate, 1.0–1.6 mm long, 0.8–1.0 mm wide, not keeled, obtuse; abaxial surface usually hairy, occasionally glabrous; margins ciliate. *Sepals* narrowly ovate, 2.0–2.7 mm long, 0.8–1.2 mm wide, obtuse; abaxial surface usually hairy (the hairs occasionally very sparse), pale green in the lower half, often becoming pink towards the apex, venation very obscure; adaxial surface glabrous; margins broadly hyaline, ciliate and/or laciniate at least in the distal half, with hairs to 0.2 mm long, very occasionally \pm glabrous. *Corolla tube* pink, \pm cylindrical or very narrowly ovoid, much longer than the sepals, 2.8–4.3 mm long, 1.0–1.4 mm wide, external surface hairy in the upper half, very occasionally \pm glabrous, internal surface hairy in the upper half to near the base of the anthers, glabrous below. *Corolla lobes* pink, shorter than the tube, 1.1–1.5 mm long, 0.5–0.8 mm wide at base, spreading from the base and recurved, external surface hairy or less often \pm glabrous, internal surface with a dense, white indumentum of terete, straight and unornamented hairs, the basal hairs reflexed and forming a dense tuft which extends well into the tube. *Anthers* fully included within the tube, 0.8–1.4 mm long, apex shallowly emarginate. *Filaments* terete, 0.1–0.2 mm long, attached just below anther apex, adnate to tube well below sinuses (i.e. $2/3$ – $3/4$ the length of the tube above the base). *Nectary* partite, the scales 0.4–0.5 mm long, 0.2–0.4 mm wide, glabrous. *Ovary* very narrowly ovoid, 1.4–2.0 mm long, 0.4–0.5 mm wide, hairy (the hairs concentrated towards the base), 3-locular, pale green or yellow-green. *Style* not or scarcely differentiated from ovary apex in flower, c. 0.2 mm long, glabrous, included within the corolla tube; stigma not or scarcely expanded. Mature *fruit* not seen. (Figure 7)

Diagnostic characters. Within the *S. tamminensis* subgroup distinguished by the following character combination: leaves opposite, narrowly ovate to narrowly elliptic with the longitudinal axis distinctly incurved; abaxial leaf surfaces shallowly to deeply grooved between the veins; leaf apex mucronate, pungent; inflorescence 1- or rarely 2-flowered; sepals usually hairy abaxially, with hyaline, ciliate and/or laciniate margins; external corolla tube usually hairy, pink; anthers fully included in the corolla tube; filaments attached to anther in the upper quarter of anther length, adnate to tube well below the sinuses; ovary hairy; style very short (c. 0.2 mm long), not or scarcely differentiated from ovary apex in flower.

Other specimens examined. WESTERN AUSTRALIA: Carani West Rd, 1.3 km E of junction with Calingiri–New Norcia Rd [SW of Yerecoin], 19 Nov. 2006, A.S. George 17771 (PERTH); Drummond Nature Reserve [W of Bolgart], c. halfway along W boundary then 300 m in, 25 Nov. 2001, M. Hislop & F. Hort MH 2485A, B, C, D (all PERTH); [Anvil block, Julimar State Forest], SW of Bolgart, 25 Nov. 2001, M. Hislop & F. Hort MH 2487 (CANB, PERTH); Wyening Reserve 20991, Fordham Rd (SSE of Calingiri), 19 Nov. 2003, F. & B. Hort 2103 (CNS, K, PERTH); Calingiri Water Reserve 17655/29461, Fordham Rd, N of Wyening East Rd, 19 Nov. 2003, F. & B. Hort 2104 (CANB, CNS, MEL, PERTH); Byroomanning Nature Reserve, Stephens Rd, Bindoon, 14 Jan. 2002, F. & J. Hort 1685 (PERTH); Wyening Reserve 20991, Fordham Rd [SSE of Calingiri], 23 Feb. 2003, F. & J. Hort 1937 (CNS, K, PERTH); Calingiri Water Reserve 17655/29461, Fordham Rd, N of Wyening East Rd, 23 Feb. 2003, F. & J. Hort 1938 (K, MEL, PERTH); Railway Reserve, Bindi Bindi Rd, Yerecoin, 2.7 km S of Yerecoin South Rd, 2 Apr. 2010, F. & J. Hort 3631 (CNS, PERTH); Bindoon Training

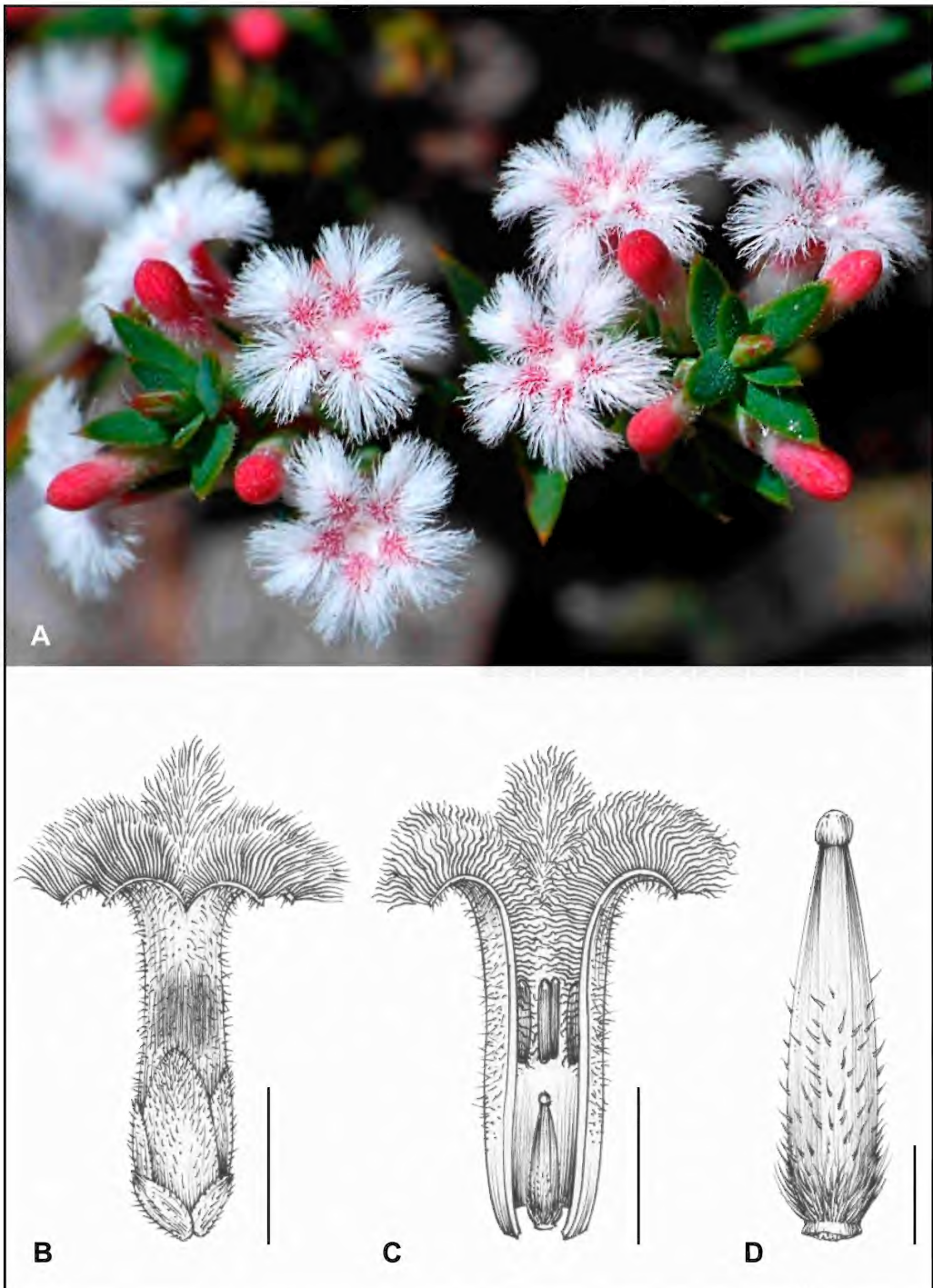


Figure 7. *Styphelia roseola*. A – flowering branchlet *in situ*; B – flower, external view; C – flower, internal view; D – ovary at flowering. Scale bars B = 2 mm; C = 2 mm; D = 0.5 mm. Voucher F. & B. Hort 2103 (B, C, D). Photograph by Fred & Jean Hort (unvouchered). Drawings by Hung Ky Nguyen.

area, Wattening (Toodyay), 1.5 km NE from Fork River crossing, 9 Dec. 2009, *F. Hort, J. Hort & M. Pazotti* 3570A (CNS, PERTH); *F. Hort, J. Hort & M. Pazotti* 3570B (CNS, PERTH); Poison Paddock [Benedictine Monastery], New Norcia, 7 Dec. 2004, *K. Macey* 803 (PERTH).

Distribution and habitat. Distributed between New Norcia and Yerecoin in the north southwards to Bindoon and Julimar State Forest; in the northern Jarrah Forest bioregion and adjacent western part of the Avon Wheatbelt. Grows in sand or light loam soils, usually over laterite or granite, in heath or open woodland. Commonly associated species include *Eucalyptus drummondii*, *Banksia armata*, *Styphelia serratifolia*, *Hakea undulata*, *H. gilbertii* and *Isopogon divergens*.

Phenology. The main flowering period is in November and December, but flowering specimens have also been collected in February and March, probably in response to summer rainfall. Mature fruit has not been collected but is likely to be present from about March until June.

Etymology. From the Latin *roseolus* (pink), a reference to the corolla colour.

Conservation status. *Styphelia roseola* has a fairly restricted distribution, on current knowledge extending about 48 kilometres on a north-south axis and 35 from east to west. It is known from three nature reserves, state forest and a water reserve. No conservation coding is recommended, but with such a limited geographical range its conservation status should be revisited at intervals.

Affinities. In terms of general morphological similarity, the taxon closest to *S. roseola* is *S. hyalina* from the Geraldton Sandplain bioregion. That species has very similar obtuse sepals with broadly hyaline margins but the abaxial surfaces and margins are always glabrous rather than variously hairy. *Styphelia roseola* also differs from *S. hyalina* in having a hairy ovary and a usually hairy corolla tube. There are further differences in the anther presentation and point of filament attachment to the corolla tube. The anthers of *S. roseola* are presented well below the corolla throat, whereas those of *S. hyalina* are held at the throat itself, and the filaments are inserted well below the sinuses rather than immediately beneath them. While *S. roseola* has a dense ring of hairs projecting into the top of the corolla tube and completely filling the orifice, these hairs are much sparser in *S. hyalina* and the anthers remain clearly visible at the top of the tube. There is an interesting, additional distinction between the two: whereas the inflorescence axis terminates in a short, bract-like point in *S. roseola*, the axis apparently ends at the flower in *S. hyalina*.

Styphelia roseola may also be confused with *S. bracteolosa* (see the treatment of the latter for differences) and *S. williamsiorum*. Apart from its more northerly distribution, *S. williamsiorum* can be distinguished from *S. roseola* by its dark purple (rather than pink) corolla pigmentation and usually recurved (rather than appressed) sepal apices. There is also a difference in the position of the filament-anther attachment, with *S. williamsiorum* having the attachment about 2/3–3/4 above the anther base rather than just below the anther apex.

Most specimens of *S. roseola* have distinctly hairy abaxial leaf surfaces, sepals with hairy abaxial surfaces and margins, and hairy corolla tubes; however, there can be considerable variation in the density of these hairs within populations (e.g. *M. Hislop & F. Hort* MH 2485A, B, C, D; *F. Hort, J. Hort & M. Pazotti* 3570A, B) and even on individual specimens. In a few collections the abaxial leaf surfaces are completely glabrous. Where this occurs it usually correlates with a reduced indumentum (sometimes to just a few hairs) on the sepals and/or the corolla tube.

Styphelia scabrella* Hislop, *sp. nov.

Typus: 3.5 km west along Belka Road from Hines Hill Road, north of Bruce Rock, Western Australia, 20 September 2001, K. Kershaw KK 2287 (*holo*: PERTH 05881641; *iso*: CANB, CNS, HO, K, MEL, NSW).

Leucopogon sp. Corrigin (K. Kershaw KK 2091), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 17 June 2022].

Spreading, compact *shrub* to *c.* 70 cm high and 70 cm wide, multi-stemmed from close to base of plant but single-stemmed at ground level, probably with a fire-sensitive rootstock. Young *branchlets* with a moderately dense to dense indumentum of patent or retrorse hairs to *c.* 0.1 mm long. *Leaves* helically arranged, steeply antrorse and frequently antrorse-appressed; apex acute, usually mucronate, innocuous to sub-pungent, the mucro straight to slightly inflexed, 0.05–0.2 mm long; base rounded to cuneate; petiole very short, 0.1–0.2 mm long, glabrous; lamina ovate or narrowly ovate, sometimes \pm triangular, 0.8–2.3 mm long, 0.6–1.2 mm wide, \pm concolorous, strongly concave and stem-clasping, at least at the base, longitudinal axis straight to slightly recurved in the upper half, becoming incurved towards apex; adaxial surface not shiny, hairy throughout, usually densely so, venation not evident; abaxial surface shiny, very shortly hairy or scabrous throughout, occasionally \pm glabrous, with 5–7 primary veins, either not grooved or shallowly grooved between the veins; margins minutely and coarsely ciliolate with antrorse hairs <0.05 mm long. *Inflorescence* axillary, erect; axis 1.5–2.8 mm long, (1)2- or sometimes 3-flowered, angular, with a dense indumentum, terminating in a bud-rudiment; flowers erect, sessile. *Fertile bracts* narrowly ovate to ovate, 1.1–1.6 mm long, 0.7–1.0 mm wide, subtended by 3 sterile bracts, the basal 2 opposite (sometimes only the basal 2 present). *Bracteoles* ovate or narrowly ovate, 1.3–2.1 mm long, 0.8–1.0 mm wide, keeled, acute and sometimes mucronate, noticeably thickened towards the apex; abaxial surface \pm scabrous; margins minutely ciliolate. *Sepals* narrowly ovate, 1.8–2.5(2.8) mm long, 0.8–1.0 mm wide, acute (and sometimes mucronate), subacute or obtuse; abaxial surface \pm scabrous, occasionally glabrous, straw-coloured or pale yellow-green in the lower half (sometimes with pink tinges), with rather thickened, green apices, only the mid-vein evident; adaxial surface with a tuft of dense hairs at the apex and sometimes a few hairs towards the base; margins ciliolate with hairs to *c.* 0.1 mm long. *Corolla tube* white, narrowly ellipsoid, narrowly ovoid, or \pm cylindrical, usually a little longer than, sometimes \pm equal to, the sepals, 1.8–2.5 mm long, 0.8–1.3 mm wide, glabrous externally, internal surface with an apical band of hairs projecting into the tube, the remainder glabrous. *Corolla lobes* white, sometimes flushed pink apically, shorter than the tube, 0.8–1.2 mm long, 0.5–0.6 mm wide at base, spreading from the base and recurved, glabrous externally, internal surfaces with a dense, white indumentum of terete, \pm straight and essentially unornamented hairs. *Anthers* fully included within the tube, 0.7–1.1 mm long, apex rounded to scarcely emarginate. *Filaments* terete, 0.1–0.2 mm long, attached to the anther at the apex, adnate to tube a little below sinuses. *Nectary* partite, the scales 0.3–0.5 mm long, 0.2–0.3 mm wide, glabrous. *Ovary* narrowly ovoid to narrowly ellipsoid, 0.8–1.3 mm long, 0.3–0.4 mm wide, with short hairs in the upper 1/3–2/3 or glabrous, 3-locular, pale green or yellow-green. *Style* scarcely differentiated from ovary apex in either flower or fruit, 0.1–0.2 mm long, glabrous or scabrous, included within the corolla tube; stigma scarcely expanded. *Fruit* cylindrical to \pm fusiform, usually curved, 3.3–4.2 mm long (inclusive of gynophore), 0.8–1.0 mm wide, much longer than the sepals, circular in section, with a well-defined gynophore; surface variously hairy in the upper half and glabrous below or glabrous throughout, \pm dry, smooth (mesocarp poorly developed), with pale, longitudinal ribs; apex acute, tapering smoothly to the base of the persistent style. (Figure 8A)

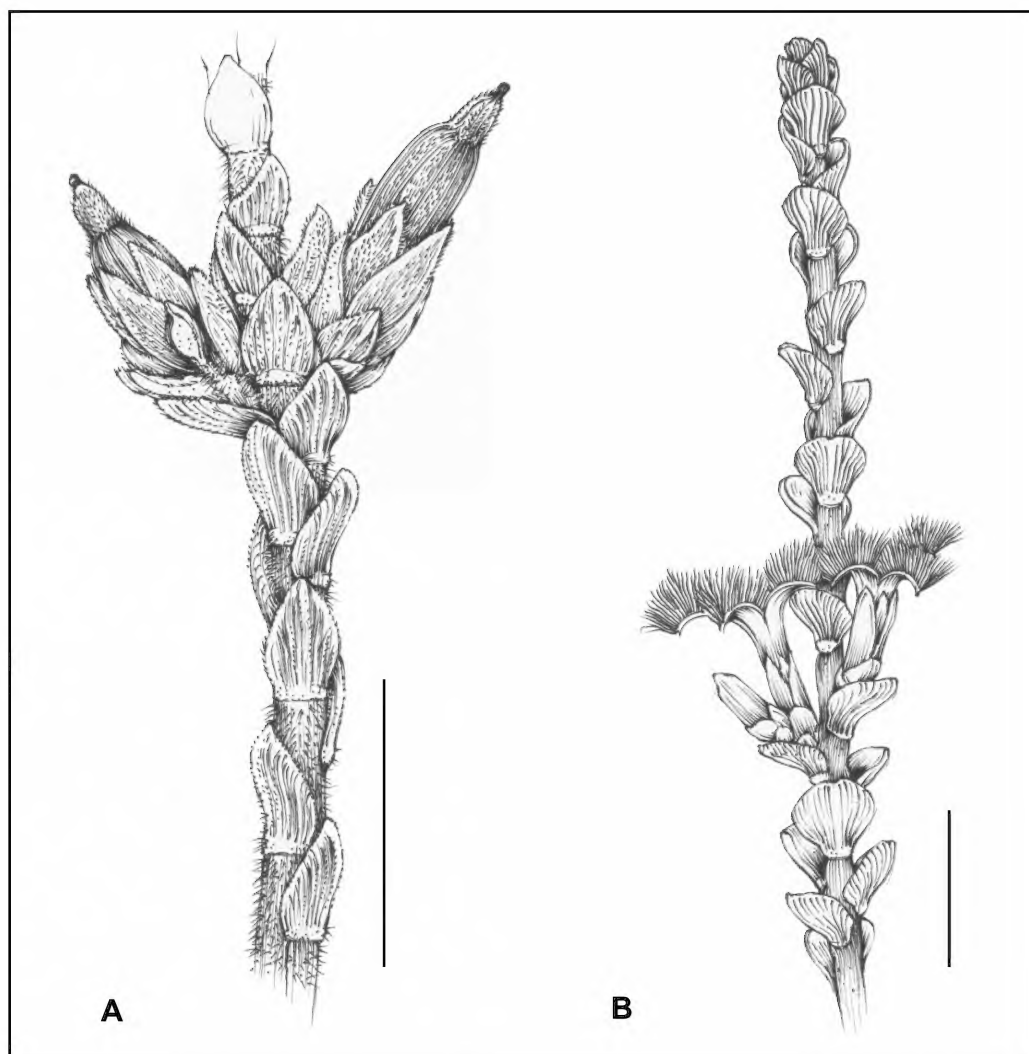


Figure 8. A – *Styphelia scabrella*, fruiting branchlet; B – *Styphelia subglauca*, flowering branchlet. Scale bars A = 3 mm; B = 4 mm. Vouchers K. Kershaw KK 2287 (A), M. Hislop 3891 (B). Drawings by Hung Ky Nguyen.

Diagnostic characters. Within the *S. tamminensis* subgroup distinguished by the following character combination: leaves helically arranged, ovate or narrowly ovate, with the longitudinal axis straight to slightly recurved in the upper half, becoming incurved towards apex; abaxial surfaces not grooved, or shallowly grooved between the veins, very shortly hairy or scabrous throughout or very occasionally \pm glabrous; adaxial surface hairy, usually densely so; apices mucronate, pungent or sub-pungent; inflorescence (1)2- or sometimes 3-flowered; sepals acute, subacute or obtuse, with well-demarcated green apices; anthers fully included within the corolla tube; filaments attached to anther at anther apex, adnate to tube just below the sinuses; ovary shortly hairy in the upper 1/3–2/3 or glabrous; style very short (0.1–0.2 mm long), scarcely differentiated from the ovary apex in flower or fruit; fruit \pm dry, cylindrical to \pm fusiform, usually curved, with an acute apex.

Other specimens examined. WESTERNAUSTRALIA: Wogarl Reserve, 22.5 km NNE of Narembeen; W side of Wogarl–Muntagin Rd, in NE portion of reserve, 27 Aug. 2000, *K. Clarke & M. Brundrett s.n.* (PERTH); Dragon Rocks Nature Reserve, S side of Mouritz Rd, 1 km from E edge of park, 10 Nov. 2001, *M. Hislop* 2444 (CANB, PERTH); Cramphorne Rd, 12.4 km E of Bruce Rock–Merredin Rd, 26 July 2002, *M. Hislop* 2706 (CNS, PERTH); Fuchsbichler Rd, 9.7 km E of Bruce Rock–Merredin Rd, NE of Bruce Rock, 11 July 2004, *M. Hislop* 3259 (CNS, NSW, PERTH); Flat Rock Nature Reserve, S of Hyden, close to SW corner, off Kulin–Holt Rock Rd, 11 Sep. 2016, *M. Hislop* 4630 (CANB, CNS, MEL, NSW, PERTH); Carstairs Rd, 7.8 km W of Southern Cross–Forrestania Rd, 16 May 2002, *M. Hislop & F. Hort* MH 2593 (CANB, PERTH); Roach Nature Reserve [N of Narembeen], off Tank Rd, 17 July 2015, *B. Hort* NM 148 (NSW, PERTH); Pederah Nature Reserve, Karlgarin Rd, Karlgarin to Kulin, 5 July 2007, *G.J. & B.J. Keighery* 1196 (CANB, CNS, K, PERTH); on S side of Pingaring–Varley Rd, 1.4 km E of Buettner Rd junction; Dragon Rocks Nature Reserve, 22 Aug. 2000, *G.J. Keighery & N. Gibson* 5594 (CANB, PERTH); on W boundary of [Lake Hurlstone Nature Reserve], 300 m N of Di Russo Rd, c. 60 km NW of Lake King, 24 Aug. 2000, *G.J. Keighery & N. Gibson* 6695 (PERTH); near breakaway, North Karlgarin Nature Reserve [NE of Kondinin], 29 June 1999, *G.J. Keighery & N. Gibson* 7223 (PERTH); 1.5 km E along Middleton Rd from Whittington Rd, S of Corrigin, 25 May 2000, *K. Kershaw* KK 2091 (CNS, K, NSW, PERTH); NW of Hyden, Worland Rd, c. 4.7 km E of Roe Rd, on N side, 8 Mar. 2000, *K. Kershaw & G. Durell* KK 2078 (CANB, CNS, MEL, PERTH); Macropcarpa Trail, 1 km from Kulin Post Office, 0.5 km from loop division, 16 Oct. 2001, *S. Murray* 471 (PERTH); Bendering Nature Reserve (No. 25681), 8 km E of Bendering Siding, 13 July 1982, *J.M. Powell* 1770 (K, L, NSW, PERTH); reserve c. 16 km due E of South Kulin on road to Dandagin Rock [N of Lake Grace], crossroads at W end of reserve, 13 July 1982, *J.M. Powell* 1783 (CANB, K, L, MEL, NSW, PERTH); 16 km N of Lake Bidy [N of Newdegate] on road to Hyden, 7 Aug. 1986, *J.M. Powell* 2232A (CANB, NSW, PERTH); 8 km N of Holleton–Ingram roads, 75 km S of Gt Eastern Hwy, 7 Aug. 1986, *J.M. Powell* 2248 (NSW, PERTH).

Distribution and habitat. Distributed in an area roughly bounded by Bruce Rock and Wogarl in the north, and Kulin and Varley in the south; in the south-east of the Avon Wheatbelt and north-west of the Mallee bioregions. Grows in heath or open mallee woodland, mostly on sand or light loam soils, often over laterite, rarely on heavier soils. Commonly associated species include *Eucalyptus macrocarpa*, *Melaleuca hamata*, *Melaleuca cordata*, *Allocasuarina acutivalvis*, *Grevillea cagiana* and *Hakea cygna*.

Phenology. Flowers have been recorded over many months of the year with no clearly discernible seasonal peak. Similarly, a high percentage of specimens include fruit at various stages of maturity, regardless of the month of collection. It seems likely that the plant responds rapidly to rainfall events.

Etymology. From the Latin *scabrellus* (minutely scabrous), a reference to the more or less scabrous surfaces of the leaves, sepals and bracteoles.

Conservation status. Fairly widely distributed in the Western Australian wheatbelt and known from several nature reserves. No conservation code applies.

Affinities. *Styphelia scabrella* is similar to, and most likely to be confused with, *S. annulata*. They are the only species in the alliance with well-demarcated, green sepal tips. They have largely allopatric distributions but with a narrow area of overlap in the Corrigin–Kulin area. Gynoecium indumentum is the most reliable means of distinguishing the two species and should be emphasised if the other distinguishing characters listed below are ever ambiguous. In *S. scabrella* the ovary is either shortly hairy in the upper third to two-thirds or else is quite glabrous, while *S. annulata* always has a ring of long hairs surrounding the base of the ovary.

In general, the shorter length of the leaves and corolla of *S. scabrella* also serve to differentiate it from *S. annulata*: the leaves are 0.8–2.3 mm (*cf.* 1.4–6.0 mm in *S. annulata*), the sepals are 1.8–2.5(2.8) mm (*cf.* 2.3–3.2(3.5) mm), the corolla tube is 1.8–2.5 mm (*cf.* 2.5–3.8 mm) and the corolla lobes are 0.8–1.2 mm (*cf.* 1.3–1.7 mm). Differences in leaf and sepal indumentum also provide further aids to identification. Whereas in *S. scabrella* the abaxial sepal surfaces are usually scabrous or occasionally \pm glabrous, in *S. annulata* the sepal surfaces are usually glabrous and only sometimes slightly scabrous. Moreover, while the adaxial leaf surface of *S. scabrella* is hairy throughout (usually densely so), in *S. annulata* it is glabrous or sparsely hairy, mostly in the lower half.

A further point of difference between the two species is that in comparison to *S. annulata*, *S. scabrella* tends to be noticeably less floriferous. This is because *S. annulata* usually has more flowers per inflorescence ((1)2–5(7) *cf.* (1)2–3 in *S. scabrella*) and these are frequently clustered in the axils of short internodes to form a contracted conflorescence. In *S. scabrella*, the unit inflorescences are fewer and more spaced along the axes.

Styphelia subglauca* Hislop, *sp. nov.

Typus: north-east of Narembeen, Western Australia [precise locality withheld for conservation reasons], 12 July 2009, M. Hislop 3891 (*holo*: PERTH 08229287; *iso*: CANB, CNS, HO, K, MEL, NSW).

Leucopogon sp. Ironcaps (N. Gibson & K. Brown 3070) *p.p.* [*auct. non* N. Gibson & K. Brown 3070], Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 17 June 2022].

Erect, *shrub* to *c.* 80 cm high and 80 cm wide, single-stemmed at ground level, with a fire-sensitive rootstock. Young *branchlets* with a usually sparse or occasionally moderately dense indumentum of patent hairs to *c.* 0.05 mm long. *Leaves* helically arranged, antrorse; apex usually obtuse to occasionally subacute; base cuneate to rounded; petiole often rather obscure, 0.1–0.4 mm long, glabrous; lamina broadly ovate or depressed-ovate to broadly obovate or depressed-obovate, sometimes \pm orbicular, 1.2–2.0 mm long, 1.2–2.0 mm wide, slightly discolorous, dull and slightly glaucous on young growth but becoming shiny, strongly concave, sometimes \pm stem-clasping in the lower half, longitudinal axis \pm straight to slightly recurved; adaxial surface usually \pm hairy in the lower half, glabrous above, venation not evident; abaxial surface paler, glabrous, with 7–9 primary veins, the midvein not or scarcely broader than the others, openly grooved between the veins; margins minutely hairy with short, stiff hairs <0.05 mm long. *Inflorescence* axillary, erect; axis 1.3–2.8 mm long, 1- or 2(3)-flowered, mostly subterete but \pm compressed above the uppermost fertile bract, with a moderately dense indumentum, terminating in a bud-rudiment; flowers erect, sessile. *Fertile bracts* ovate or narrowly ovate, 0.6–1.2 mm long, 0.5–0.7 mm wide, subtended by 3(4) sterile bracts, the basal 2 opposite. *Bracteoles* broadly ovate or \pm orbicular, 1.0–1.3(1.5) mm long, 0.8–1.2 mm wide, keeled, obtuse; abaxial surface glabrous; margins ciliate with longer hairs towards the apex. *Sepals* narrowly ovate, 2.2–2.5 mm long, 0.9–1.3 mm wide, obtuse; abaxial surface glabrous, pale green or straw-coloured, sometimes becoming brown and necrotic, venation very obscure, with only the mid-vein evident or not; adaxial surface with a tuft of hairs towards the base and at the apex, glabrous or sparsely hairy in between; margins ciliate with hairs to *c.* 0.3 mm long, the longest towards the apex. *Corolla tube* white, narrowly ovoid to narrowly ellipsoid, a little longer than (rarely *c.* as long as) the sepals, 1.9–2.6 mm long, 1.1–1.5 mm wide, glabrous externally, internal surface hairy towards the apex with hairs projecting downwards to a point below the middle of the anthers, glabrous below. *Corolla lobes* white, shorter than the tube, 1.0–1.6 mm long, 0.5–0.7 mm wide at base, spreading from close to the base and recurved, glabrous externally, internal surface with a dense indumentum of terete, \pm straight and essentially unornamented hairs. *Anthers* fully included within the tube, 1.0–1.3 mm long, apex rounded to scarcely emarginate.

Filaments terete, 0.1–0.2 mm long, attached to anther at the apex, adnate to tube just or sometimes distinctly below the sinuses. *Nectary* partite, the scales 0.3–0.5 mm long, 0.2–0.4 mm wide, glabrous. *Ovary* narrowly ellipsoid, 1.0–1.2 mm long, 0.4–0.5 mm wide, glabrous, 3-locular, yellow-green or straw-coloured. *Style* smoothly attenuated from (and with the base not clearly differentiated from) the ovary apex, 0.3–0.4 mm long, faintly papillose, included within the corolla tube; stigma not or scarcely expanded. *Fruit* ± cylindrical or fusiform, sometimes curved, 2.8–3.3 mm long (inclusive of gynophore), 0.8–1.0 mm wide, much longer than the sepals, circular in section, with a well-defined gynophore; surface glabrous, ± dry, smooth (mesocarp poorly developed), with pale, longitudinal ribs; apex acute, tapering smoothly to the style base; style persistent or not. (Figure 8B)

Diagnostic characters. Within the *S. tamminensis* subgroup distinguished by the following character combination: leaves helically arranged, ± glaucous, at least when young, broadly ovate or depressed-ovate to broadly obovate or depressed-obovate, sometimes ± orbicular, with the longitudinal axis straight to slightly recurved; abaxial leaf grooves open between the veins, glabrous on the vein surfaces and within the grooves; leaf apex innocuous, non-mucronate; inflorescence 1- or 2(3)-flowered; anther tips included within the tube; filaments attached to anther at anther apex, adnate to tube just below (or sometimes distinctly below) the sinuses; ovary glabrous; style 0.3–0.4 mm long; fruit ± dry, ± cylindrical or fusiform, with an acute apex.

Other specimens examined. WESTERN AUSTRALIA: 4 Feb. 1963, *A.S. George* 4295 (CANB, PERTH); 28 Sep. 1997, *G.J. Keighery & N. Gibson* 3757 (PERTH); 28 Sep. 1997, *G.J. Keighery & N. Gibson* 6753 (PERTH); 8 Aug. 2001, *K. Kershaw & M. Golding* KK 2255 (PERTH); 8 Aug. 2001, *K. Kershaw & M. Golding* KK 2260 (CNS, PERTH); 15 June 1994, *Merredin Herbarium* BP 02 (PERTH); 23 July 2003, *S. Patrick* 4169 (PERTH); 30 July 1986, *J.M. Powell* 2242A (NSW, PERTH).

Distribution and habitat. Distributed from Merredin in the north, south and eastwards to east of Hyden, in the far east of the Avon Wheatbelt and northwest of the Mallee bioregions. Grows in open mallee woodland or heath, mostly in sand over laterite. Common associated species include *Eucalyptus burracoppinensis*, *Allocasuarina acutivalvis*, *Hakea platysperma*, *Acacia rossii*, *Drummondita hassellii* and *Melaleuca calyptroides*.

Phenology. The most prolifically flowering collections of the species were made in July and August, but some mature fruit were also present on the same specimens suggesting that, in common with other species from the *S. tamminensis* subgroup, flowering is likely to be intermittent over many months.

Etymology. From the Latin *glaucus* (having a bluish-grey bloom) with the prefix *sub-* (not completely, a little), a reference to the usual appearance of the young growth. This is intended to highlight one of the differences between this species and the similar *S. platyneura*.

Conservation status. *Styphelia subglauca* is currently known from two nature reserves and a water reserve but has a fairly restricted distribution in a part of the state that has been subject to heavy clearing for agriculture. To be listed as Priority Three under Conservation Codes for Western Australian Flora (T. Llorens pers. comm.).

Affinities. As noted under *S. platyneura*, *S. subglauca* was previously included within the concept of *Leucopogon* sp. Ironcaps, but as increasing numbers of specimens became available for study it became apparent that a second, allopatric species could be recognised based on differences in indumentum, and bract and leaf morphology (Table 1).

Table 1. A comparison of key morphological features and distributions of *Styphelia platyneura* and *S. subglauca*.

| Character | <i>S. platyneura</i> | <i>S. subglauca</i> |
|--|---|---|
| Sepal and bracteole indumentum | Shortly hairy, at least in the upper half | Glabrous |
| Bracteole size and shape | 1.3–1.7 mm long, 1.0–1.2 mm wide, ovate | 1.0–1.3(1.5) mm long, 0.8–1.2 mm wide, broadly ovate or ± orbicular |
| Leaf size and shape | 1.3–2.0 mm long, 1.0–1.6 mm wide, obovate to ovate or broadly so, usually distinctly longer than wide | 1.2–2.0 mm long, 1.2–2.0 mm wide, broadly ovate or depressed-ovate to broadly obovate or depressed-obovate, sometimes ± orbicular, frequently wider than long |
| Leaf aspect, abaxial venation and indumentum | Young leaves olive green, non-glaucous. Midvein very prominent; deeply and openly grooved between veins, often with short, stiff hairs on the veins | Young leaves ± glaucous. Midvein less prominent; more shallowly grooved between the always glabrous veins |
| Young branchlet indumentum | Moderately dense, with hairs to c. 0.1 mm long. | Usually sparse, occasionally moderately dense, with hairs to c. 0.05 mm long. |
| Distribution | From the Forrestania district, south and eastwards to the eastern part of Frank Hann National Park | From Merredin in the north, south and eastwards to east of Hyden |

Styphelia tamminensis (E.Pritz.) Sleumer, *Blumea* 12(1): 154 (1964); *Leucopogon tamminensis* E.Pritz., in F.L.E. Diels & E.G. Pritzel, *Bot. Jahrb. Syst.* 35(2): 479 (1904). *Typus*: In distr. Avon in planitiebus arenosis prope Tammin [Western Australia], May 1901, *E. Pritzel* 318 (*lecto*: L 0006585 image!, designated by H. Sleumer, *Blumea* 12(1): 154 (1964); *isolecto*: BM 001040169 image!, GH 00061366 image!, HBG-507606 image!, K 000348951 image!, M-0164823 image!, PERTH 01598406!, PERTH 09008551!, S 08-5912 image!, US 00113632 image!).

Distribution. *Styphelia tamminensis* has a significantly disjunct distribution which is grouped in three distinct clusters. The northernmost is in the Marchagee–Watheroo area of the Geraldton Sandplains bioregion, and there are two clusters in the Avon Wheatbelt, one around Wongan Hills and the most southerly around Tammin.

Conservation status. Currently listed as Priority Two under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–). It seems quite possible that *S. tamminensis* is no longer extant in the area that gave the species its name. Aside from the type gathering itself there is only one other collection from this heavily cleared part of the wheatbelt and that was made 90 years ago. Similarly, there are only three collections from Marchagee–Watheroo area and two of those were made 75 years ago. The last refuge of the species is in the Wongan Hills area, and even there it is not a common plant locally.

Notes. The morphology of plants from the Wongan Hills and Tammin clusters is comparable, but two of the three collections from the Marchagee–Watheroo area differ from the typical form in an interesting way: rather than having the usual adaxially concave leaf lamina, the leaf margins are distinctly recurved. This makes them very unusual not just within the *S. tamminensis* subgroup but

in the wider context of all Western Australian members of Group X. The only other species from the group that is known to sometimes have entirely convex leaves is *S. recurva*.

Styphelia williamsiorum Hislop & Puente-Lel., *Nuytsia* 28: 110, figs 6, 8, 9 (2017). *Typus*: Badgingarra National Park, Western Australia [precise locality withheld for conservation reasons], 13 November 2004, *M. Hislop* 3346 (*holo*: PERTH 07202911; *iso*: CANB, NSW 940617).

Leucopogon sp. Warradarge (M. Hislop 1908), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [before March 2017].

Distribution. Occurs from south of Eneabba to the Badgingarra area and east to Alexander Morrison National Park, in the Geraldton Sandplains bioregion.

Conservation status. Recently listed as Priority Three under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–).

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We would especially like to thank Kim Kershaw and Fred and Jean Hort, whose systematic collections in the late 1990s and early 2000s helped the first author enormously in understanding the patterns of variation within several members of the *S. tamminensis* subgroup, as well as in helping to confirm their distributions. We are also very grateful to Juliet Wege who in her editorial role suggested some significant textual improvements.

References

- Candolle, A.P. de (1839). *Prodromus Systematis Naturalis Regni Vegetabilis* Vol 7(2). (Treuttel et Wurtz: Paris.)
- Crayn, D.M., Hislop, M. & Puente-Lelièvre, C. (2020). A phylogenetic recircumscription of *Styphelia* (Ericaceae, Epacridoideae, Styphelieae). *Australian Systematic Botany* 33: 137–168.
- Department of Climate Change, Energy, the Environment and Water (2021). *Australia's bioregions*. <https://www.dcceew.gov.au/environment/land/nrs/science/ibra#ibra> [accessed 3 October 2022].
- Gibson, N. (2018). The Australian plant collections of Diels and Pritzel 1900–1902. *Nuytsia* 29: 25–39.
- Hislop, M. (2021). Interim key to, and composition of, species groups in Western Australian *Styphelia*. *Nuytsia* 32: 29–37.
- Hislop, M. & Puente-Lelièvre, C. (2017). Five new species of *Styphelia* (Ericaceae: Epacridoideae: Styphelieae) from the Geraldton Sandplains, including notes on a new, expanded circumscription for the genus. *Nuytsia* 28: 95–116.
- Powell, J.M., Morrison, D.A., Gadek, P.A., Crayn, D.M. & Quinn, C.J. (1997). Relationships and generic concepts within Styphelieae (Epacridaceae). *Australian Systematic Botany* 10: 15–29.
- Puente-Lelièvre, C., Hislop, M., Harrington, M., Brown, E.A., Kuzmina, M. & Crayn, D.M. (2016). A five-marker molecular phylogeny of the Styphelieae (Epacridoideae, Ericaceae) supports a broad concept of *Styphelia*. *Australian Systematic Botany* 28: 368–387.
- Quinn, C.J., Crayn, D.M., Heslewood, M.M., Brown, E.A. & Gadek, P.A. (2003). A molecular estimate of the phylogeny of Styphelieae (Ericaceae). *Australian Systematic Botany* 16: 581–594.
- State of Western Australia (2022). Biodiversity Conservation (Listing of Native Species) (Flora) Order 2022. Western Australian Government Gazette 2022(144): 4763–4768. <https://www.legislation.wa.gov.au/legislation/statutes.nsf/gazettes2022.html>
- Taaffe, G., Brown, E.A., Crayn, D.M., Gadek, P.A. & Quinn, C.J. (2001). Generic concepts in Styphelieae: resolving the limits of *Leucopogon*. *Australian Journal of Botany* 49: 107–120.
- Western Australian Herbarium (1998–). *Florabase—the Western Australian Flora*. Department of Biodiversity, Conservation and Attractions. <https://florabase.dpaw.wa.gov.au/> [accessed 11 November 2022].

Reduction of *Corynanthera* to the synonymy of *Micromyrtus* (Myrtaceae: Chamelaucieae: Micromyrtinae)

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SHORT COMMUNICATION

During the late 1970s, the curator of the Western Australian Herbarium John Green began a taxonomic study of Myrtaceae subtribe Thryptomeninae Benth. *sensu* Benth. (1867). He took a particular interest in anther morphology (see Green 1980), which led him to recognise two new genera, *Corynanthera* J.W.Green (Green 1979) and *Malleostemon* J.W.Green (Green 1983), the former genus comprising the single species *C. flava* J.W.Green.

While *Corynanthera* has a bizarre anther morphology that distinguishes it from all other members of the Myrtaceae, other aspects of its morphology tie it very closely to *Micromyrtus* Benth. Green (1979: 373) was certainly aware of this as he stated: ‘The ovary of *Corynanthera* closely resembles that of a group of species of *Micromyrtus* having 10 stamens and two ovules, suggesting a very close relationship’. A molecular study (Wilson *et al.* 2004) seemed to support this since *Corynanthera* was placed with the single Western Australian species sampled, *Micromyrtus elobata* (F.Muell.) Benth., which has ten stamens and two ovules, whereas three eastern Australian species with more numerous ovules formed a separate clade.

Green abandoned his studies of *Micromyrtus* in the late 1980s and no further publications appeared until additional eastern Australian species of *Micromyrtus* species were described by Hunter *et al.* (1996) and Bean (1997). Interest in *Corynanthera* was renewed when work on Western Australian species of *Micromyrtus* led to two publications (Rye 2002, 2006) in which the morphology of *Corynanthera* was compared with *Micromyrtus*, uncovering some additional unique characters in *Corynanthera* (see *Notes* below). In the second paper (Rye 2006), it was noted that the first attempt to obtain nuclear DNA sequences for *Corynanthera* had failed.

The most recently published molecular study (Rye *et al.* 2020: 202) resulted in the naming of the new subtribe Micromyrtinae Rye & Peter G. Wilson, comprising *Corynanthera* and *Micromyrtus* but noted that ‘*Corynanthera* is probably nested within the much larger genus *Micromyrtus*: a paper dealing with phylogenetic relationships within *Micromyrtus* is planned’. Although the planned phylogenetics paper is still far from completion, the relevant analyses (P.G. Wilson & M.M. Heslewood, unpublished obs.) indicate that *Corynanthera* is strongly sister to both subspecies of *Micromyrtus elobata* and this

clade stands apart from all other species sampled, both eastern and western. Inclusion of *M. elobata* within *Corynanthera* is not feasible on morphological grounds as that would negate all the characters that currently separate *Corynanthera* from *Micromyrtus*. Retaining *Corynanthera* by the recognition of *M. elobata* as a new monotypic genus would also be difficult to justify on morphological grounds.

Re-examination of the morphology of *Corynanthera* and *Micromyrtus* during the preparation of flora treatments for them suggests that *C. flava* is most similar to *M. rogeri* J.W.Green ex Rye, a species that has not been sampled for DNA. It would certainly be of interest, in the future, to investigate a possible close relationship between *M. rogeri* and *Corynanthera*. Meanwhile we have decided to precede a paper on phylogenetic relationships with this paper, reducing *Corynanthera* to a synonym of *Micromyrtus*; this will expedite the preparation of full flora treatments of *Micromyrtus* species for the electronic *Flora of Australia* project. The new combination necessitates an updated description of *Micromyrtus* to accommodate several characters that were previously excluded from the genus.

Micromyrtus Benth., in G. Bentham & J.D. Hooker, *Gen. Pl.* 1: 700 (1865); *Thryptomene* sect. *Micromyrtus* (Benth.) F.Muell., *Fragm.* 8: 13 (1873). *Type: Micromyrtus drummondii* Benth. *nom. superfl.* = *Micromyrtus obovata* (Turcz.) J.W.Green; lecto, *fide* B.L. Rye, *Nuytsia* 15: 102 (2002).

Corynanthera J.W.Green, *Nuytsia* 2(6): 368 (1979). *Type: Corynanthera flava* J.W.Green = *Micromyrtus flava* (J.W.Green) Rye & Peter G. Wilson.

Shrubs almost prostrate to very tall, with slender branches. *Leaves* opposite, decussate, concolorous or paler adaxially; apical point absent or up to 0.3 mm long. *Peduncles* 1-flowered. *Pedicels* absent in almost all species. *Flowers* small, actinomorphic or zygomorphic. *Hypanthium* obconic or narrowly obconic to strongly dorsiventrally compressed, 4–10-ribbed or 5-angled. *Sepals* (when present) 5 or 6, extremely short to about as long as the petals, persistent in fruit. *Petals* 5 or 6, widely spreading in flower, orbicular or obovate, white to medium pink or yellow; antipetalous colletes absent or minute. *Staminodes* rare or absent. *Stamens* inflexed in bud, free, 5–10 or 12, with 1 opposite each petal and, in many species, also with 1 opposite each sepal, much shorter than the petals, the antisepalous ones (when present) often distinctly shorter and inserted lower than the antipetalous ones. *Filaments* filiform or (in two species) flattened. *Anthers* (in most species) longitudinally dehiscent, with slits greatly to slightly divergent at summit, dehiscent by a central pore in *M. flava*; connective gland free, large and in one species stalked, often accompanied by 2 much smaller oil glands. *Ovary* inferior, 1-locular; placenta sessile, located towards top of ovary; ovules 1–10, somewhat pendulous. *Style* central and terminal; stigma minute. *Fruits* indehiscent, 1(2)-seeded, sometimes with persistent petals or bracteoles. *Seeds* often truncate-obovoid or dorsiventrally compressed, 0.9–2.5 mm long; testa membranous.

Diagnostic characters. Distinguished by the following combination of characters: stamens inflexed in bud, free, 5–10 or 12, with 1 opposite each petal and, in most species, also with 1 opposite each sepal, the antisepalous stamens (when present) shorter and often inserted lower than the antipetalous stamens; anthers longitudinally dehiscent, with slits widely divergent at summit or subparallel, or (in one species) dehiscent by a central pore, the connective gland free; ovary 1-locular, with the ovules somewhat pendulous from a placenta located towards the top of the ovary; style terminal (not inset); fruits indehiscent.

Distribution and habitat. A genus with 50 species currently recognised, widely distributed across mainland Australia, with a high concentration of species in the south-west of Western Australia and a smaller concentration in eastern Queensland and New South Wales.

Notes. The type species of *Corynanthera*, now known as *Micromyrtus flava* (J.W.Green) Rye & Peter G.Wilson, is a very distinctive species (Figure 1). It is unique in the following characters:

1. Anther morphology. This remains the most remarkable characteristic of *M. flava* since it is unique within the whole Myrtaceae. *Micromyrtus flava* has a long-stalked connective gland that protrudes beyond the apex of the anther and its thecae are fused into a structure that is dehiscent by a single pore (see Green 1979, 1980).
2. Hypanthium ribbing and dimorphic sepals (see Rye 2006: 120, Figure 1A–C). There is a great diversity of longitudinal ribbing on the hypanthium in *Micromyrtus* and the unique kind in *M. flava* (Rye 2002, 2006) is not any more remarkable than the kinds found in other members of the genus.

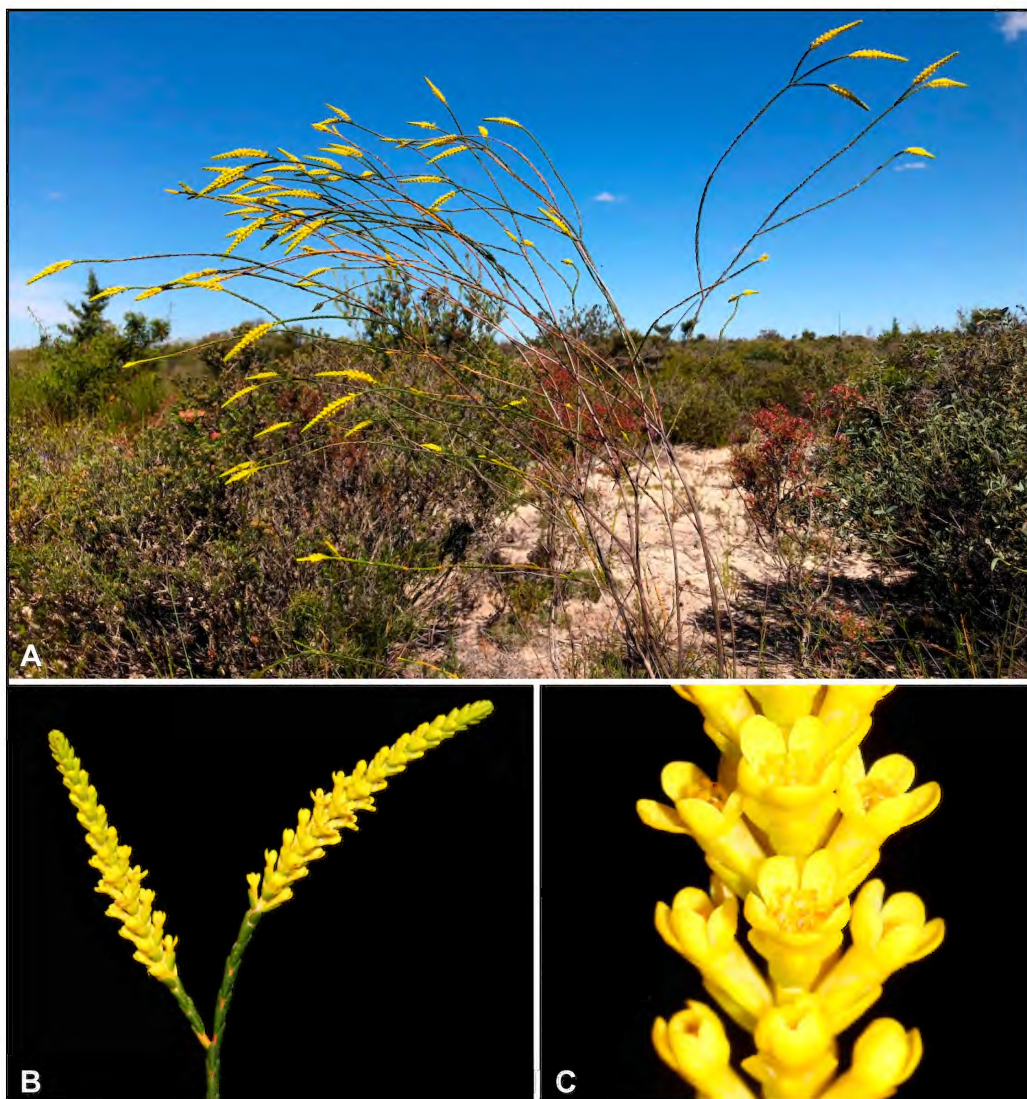


Figure 1. *Micromyrtus flava*. A – habit; B – inflorescences; C – flowers. Photographs by J.A. Wege from *C.J. Ely 2* & J.A. Wege (PERTH).

More significant is the increased zygomorphy of the flowers in *M. flava* resulting from having the sepals differing on the two surfaces of the greatly compressed hypanthium, with two broad sepals on the abaxial surface and three narrower sepals on the adaxial surface.

3. Diaspore morphology (see Rye 2006: 120, Figure 1A–C). While *M. rogeri* and several other *Micromyrtus* species have a markedly compressed fruit, only *M. flava* has the peduncle fused laterally to the bracteoles and distally to the base of the hypanthium. The bracteoles act as wings on each side of the diaspore, increasing the diaspore's ability to remain airborne when shed from the plant.

These new characters are incorporated in the generic description above.

Micromyrtus flava (J.W.Green) Rye & Peter G.Wilson, *comb. nov.*

Corynanthera flava J.W.Green, *Nuytsia* 2(6): 371–372 (1979). *Type*: 34.6 km west of Winchester, Western Australia, 6 December 1978, *J.W. Green* 4918 (*holo*: PERTH 01079166; *iso*: AD 98043406, CANB 292493, *K n.v.*, PERTH 01079182).

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References

- Bean, A.R. (1997). A revision of *Micromyrtus* Benth. (Myrtaceae) in Queensland. *Austrobaileya* 4: 455–476.
- Benthams, G. (1867). *Flora Australiensis*. Vol. 3. (Reeve and Co.: London.)
- Green, J.W. (1979). *Corynanthera*, a new genus of Myrtaceae (subfamily Leptospermoideae, tribe Chamelaucieae). *Nuytsia* 2: 368–374.
- Green, J.W. (1980). A revised terminology of the spore-containing parts of anthers. *New Phytologist* 84: 401–406.
- Green, J.W. (1983). *Malleostemon*, a new genus of Myrtaceae (subfamily Leptospermoideae, tribe Chamelaucieae) from south-western Australia. *Nuytsia* 4: 295–315.
- Hunter, J.T., Quinn, F.C. & Bruhl, J.J. (1996). *Micromyrtus grandis* (Myrtaceae), a new species from New South Wales. *Telopea* 7: 77–79.
- Rye, B.L. (2002). A revision of south-western Australian species of *Micromyrtus* (Myrtaceae) with a five-ribbed hypanthium. *Nuytsia* 15: 101–122.
- Rye, B.L. (2006). A partial revision of south-western Australian species of *Micromyrtus* (Myrtaceae: Chamelaucieae). *Nuytsia* 16: 117–147.
- Rye, B.L., Wilson, P.G., Heslewood, M.M., Perkins, A.J. & Thiele, K.R. (2020). A new subtribal classification of Myrtaceae tribe Chamelaucieae. *Australian Systematic Botany* 33: 191–206.
- Wilson, P.G., Heslewood, M.M., Lam, N. & Quinn, C. (2004). Progress towards a phylogeny of the *Chamelaucium* alliance (Myrtaceae). *Australian Biologist* 17: 28–33.

Synonymisation of taxa, correction of a misapplied name and an updated key for the Western Australian *Leptospermum erubescens* species group (Myrtaceae: Leptospermeae)

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SHORT COMMUNICATION

Leptospermum J.R.Forst. & G.Forst. is a large genus of Australian Myrtaceae. The last major revision of the genus was undertaken by Thompson (1989) who recognised 79 species, including 27 that were newly described in that paper. Since that time, the taxonomy has remained relatively stable with just a few new species added (Bean 1992; Lyne 1993; Lyne & Crisp 1996; Bean 2004). In her revision, Thompson (1989) recognised that the group might consist of multiple genera and indeed, molecular work has since revealed the genus to be polyphyletic (O'Brien *et al.* 2000; Binks *et al.* 2022). A major reclassification of the genus is currently underway that will resolve this polyphyly through the recognition of four additional genera. However, because that work is still ongoing, we continue to treat the focal species in this paper as *Leptospermum*.

One of the proposed new genera (Subclade B4 of Binks *et al.* 2022, also referred to here as the *L. erubescens* species group) consists of a small complex of ten morphologically similar Western Australian species that were poorly resolved in the broad phylogenomic datasets of Binks *et al.* (2022). Subsequently, this group was investigated using a more targeted, population genomic approach (Binks & Byrne 2022) that delimited six to eight species. These data confirmed the molecular distinctiveness of four species currently recognised as *L. fastigiatum* S.Moore, *L. inelegans* Joy Thomsps. (now understood to be *L. roei* Benth. *s. str.*, refer below), *L. maxwellii* S.Moore and *L. sericeum* Labill. The genomic data did not support the retention of two other taxa: *L. sp.* Peak Charles/Norseman (K.R. Newbey 5243) as distinct from *L. incanum* Turcz., or *L. roei sensu* Thompson (1989) as distinct from *L. nitens* Turcz. There is also little morphological distinction within each of these pairs, such that their continued recognition as separate species is unwarranted. The final two species in this group, *L. erubescens* Schauer and *L. oligandrum* Turcz., presented a significantly more complex picture that is detailed in Binks and Byrne (2022) and is not dealt with here because it requires extensive morphological evaluation before taxonomic decisions can be made. Thus, at this time, these two species are retained as currently circumscribed.

Here, our original intention was to update the taxonomy of this group to synonymise *L. sp.* Peak Charles/Norseman under *L. incanum* and *L. roei sensu* Thompson (1989) under *L. nitens*. In the process of reviewing the relevant type specimens (specimens viewed on Global Plants, <https://plants>).

jstor.org/, are indicated below as image!), we discovered that the name *L. roei* had been misapplied by Thompson (1989) and should be applied to what is currently known as *L. inelegans*. Thus, in addition to formalising these synonymies, we also resolve the misapplication, as detailed in the following treatment notes. Finally, we present an updated key to the eight species of the *L. erubescens* group.

Leptospermum incanum Turcz., *Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Petersbourg* 10: 335 (1852). *Type*: Nova Hollandia [Western Australia], 1847–1849, *J. Drummond* 5: 130 (*holo*: KW 001001311 image!; *iso*: G 00223273 image!; K 000843063 image!; MEL 615728 image!, NSW 510664 image!, PERTH 01638262!).

Leptospermum erubescens var. *strictum* Benth., *Fl. Austral.* 3: 109 (1867) *p.p.* with respect to the following syntypes. *Type*: S.W. Australia, 1850 [1847–1849], *J. Drummond* 5: 130 (*syn*: K 000843063 image!; *isosyn*: G 00223273 image!; KW 001001311 image!; MEL 615728 image!, NSW 510664 image!, PERTH 01638262!); Phillips and Oldfield R[ivers], *Maxwell s.n.*, *s. dat.* (*syn*: MEL 103701 image!).

Leptospermum sp. Peak Charles/Norseman (K.R. Newbey 5243), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 18 May 2022].

Notes. Since its installation, the status of *L. sp. Peak Charles/Norseman* has been problematic with no clear morphological differences evident between it and *L. incanum*. There are specimens of both taxa in the Western Australian Herbarium labelled as '*L. sp. nov. c*' by Joy Thompson from the early 1980s. Although this taxon was later recognised as *L. incanum* in Thompson (1989), not all of the specimens were redetermined accordingly, and the phrase name, *L. sp. Peak Charles/Norseman*, was raised much later in the mid-1990s for the overlooked specimens. Genomic confirmation of their conspecific status by Binks and Byrne (2022) has provided the impetus to resolve this outstanding taxonomic oversight and reduce *L. sp. Peak Charles/Norseman* to synonymy.

The names *L. incanum* Turcz. and *L. erubescens* var. *strictum* Benth., although independently published, were based on (or in the case of *L. erubescens* var. *strictum* partly based on) the collection *Drummond* 5: 130. Apparently Bentham was unaware of Turczaninow's publication. Similarly *L. nitens* Turcz. (see below) was based on another syntype of *L. erubescens* var. *strictum*.

Leptospermum nitens Turcz., *Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Petersbourg* 10: 335 (1852).

Type: Nova Hollandia [Western Australia], 1847–1849, *J. Drummond* 5: Suppl. 28 (*holo*: KW 001001312 image!; *iso*: G 00223331 image!, K 000843062 image!, MEL 103709 image!, NSW 510675 image!, PERTH 01831127!).

Leptospermum erubescens var. *strictum* Benth., *Fl. Austral.* 3: 109 (1867) *p.p.* with respect to the following syntype. *Type*: S.W. Australia, 1847–1849, *J. Drummond* 5: Suppl. 28 (*syn*: K 000843062 image!; *isosyn*: G 00223331 image!; KW 001001312 image!; MEL 103709 image!, NSW 510675 image!, PERTH 01831127!).

Leptospermum roei auct. non Benth.: Joy Thoms., *Telopea* 3: 374–376 (1989); G. Paczkowska & A.R. Chapman, *West. Aust. Fl.: Descr. Cat.*: 390 (2000); S.D. Williams, L. Pappalardo, J. Bishop & P.R. Brooks, *J. Agric. Food Chem.* 66: 11133–11140 (2018); R.M. Binks, M. Heslewood, P.G. Wilson & M. Byrne, *Taxon* 71: 348–359 (2022); R.M. Binks & M. Byrne, *Bot. J. Linn. Soc.* 200: 378–394 (2022); Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [before July 2022].

Notes. While reviewing relevant type images during a late stage of the preparation of this paper it was discovered that Thompson (1989) had misapplied the name *L. roei*. This necessitated a change to the species in need of synonymising. Instead of *L. roei* being sunk into *L. nitens* as was originally thought, it became evident that *L. inelegans* would have to be synonymised under *L. roei*.

It appears that Thompson did not personally view a type for *L. roei* but instead relied on observations of the Kew holotype made in 1938 by Charles Gardner, in which he matched a PERTH specimen (*M. Koch* 2770) with that type. Unfortunately, Gardner erred in making this match. His matched specimen, *M. Koch* 2770, is not referable to the true *L. roei*, but rather to a morphotype that we now recognise as morphological variation in *L. nitens* with spreading hypanthium hairs. This was an understandable mistake at a time when there were far fewer collections available by which to judge infraspecific variation. The error led to Thompson's acceptance of this variant of *L. nitens* as *L. roei*, and also to her subsequent description of *L. inelegans* to accommodate what then appeared to be an unnamed species. All publications since Thompson, including those of the current authors hitherto, have followed suit in misapplying the name *L. roei*.

In consequence of Thompson's acceptance that *M. Koch* 2770 matched the type of *L. roei*, her descriptions of *L. nitens* and *L. roei* are near identical with only slight differences in measurement ranges (e.g., leaf length ranges 5–12 mm in *L. nitens* and 7–13 mm in *L. roei*). The only substantive morphological difference given was the orientation of the hypanthium hairs: appressed in *L. nitens*, spreading in *L. roei*. The two morphological forms are equally common, often co-occur at the same sites and occupy the same geographical range and habitat (Binks & Byrne 2022). It is maybe surprising that Thompson did not treat the morphotype with spreading hairs as simply morphological variation in *L. nitens*. In her description of *L. inelegans* she notes that although the hypanthium in that species usually has an appressed indumentum it may also, occasionally, be spreading. Numerous collections of the species have been made since Thompson's treatment and they indicate that in fact the form with spreading hypanthium hairs is at least as common as the type form and, similar to that seen in *L. nitens*, the morphological variation regularly co-occurs at the same locations across their shared geographic distribution (Binks & Byrne 2022). Something that might have alerted Thompson to Gardner's mismatch was Bentham's description of the flowers of *L. roei* as 'nearly sessile'. Examination of the Kew holotype of the species via JSTOR Global Plants supports Bentham's observation. While the pedicels of *L. nitens* (including the morphotype with spreading hypanthium hairs) can sometimes be as short as 1.5 mm long they are always clearly discernible, whereas in *L. roei* they are frequently so short as to make the flowers appear more or less sessile.

Binks and Byrne (2022) demonstrated a lack of genomic distinction between plants with appressed and spreading hair variation in *L. inelegans* (= *L. roei* s. str.), and similarly, no distinction between *L. nitens* and *L. roei sensu* Thompson. This provides a strong indication that hypanthium hair orientation is not a useful taxonomic character in the *L. erubescens* species group.

Leptospermum roei Benth., *Fl. Austral.* 3: 110 (1867). *Type*: In the interior [of Western Australia], s. dat. [but probably 1848–1850], *J.S. Roe s.n.* (*holo*: K 000843061 image!).

Leptospermum inelegans Joy Thoms., *Telopea* 3: 376–377 (1989). *Type*: 40 km E of Lake King, Western Australia, 17 September 1976, *R. Hnatiuk* 760783 (*holo*: PERTH 01638270!).

Key to the *Leptospermum erubescens* species group¹

¹This is a natural grouping corresponding to Subclade 4B of Binks *et al.* (2022). It is exclusively Western Australian and constitutes one of four proposed new genera. The key was adapted from earlier keys by Thompson (1989) and Barbara Rye (unpublished).

When negotiating the key presented below users should be aware that aside from the relatively distinctive *L. sericeum*, species within the *L. erubescens* group defy neat morphological circumscription and hence many specimens will not unambiguously key to species. Recent genetic research and associated fieldwork (Binks & Byrne 2022) has highlighted at least one of the probable causes of the difficult taxonomy in this group. One of their key findings was that where more than one species is present in any given area, hybridisation is very likely to occur with the effect of blending morphological features. Apomixis is also suspected to occur widely across this group and may contribute to propagating unusual morphologies resulting from hybridisation.

1. Young stems shallowly tuberculate (but sometimes hidden by hairs). Ovary 3-locular in all or most flowers (S of Tammin–Great Victoria Desert)..... **L. fastigiatum**
- 1: Young stems not tuberculate. Ovary usually 4- or 5-locular in all or most flowers
 2. Largest leaves 6–12 mm wide. Anther cells *c.* 0.6 mm long. Mature fruits 6–8 mm wide (Cape Le Grand NP & W of Recherche Archipelago)..... **L. sericeum**
 - 2: Largest leaves 2–5 mm wide. Anther cells 0.25–0.5 mm long. Mature fruits 2.5–5 mm wide
 3. Pedicels 0.5–1.5(2) mm long, flowers often appearing \pm sessile. Hypanthium very densely hairy with spreading or appressed hairs; upper part of fruiting hypanthium angled inwards over the top of the fruit (W of Tarin Rock–Frank Hann NP–E of Cascade) **L. roei**
 - 3: Pedicel 1.5–7 mm long. Hypanthium variously hairy or glabrous; fruiting hypanthium not as above
 4. Mature fruits (including pedicel), usually as broad as long, with a conspicuous rim formed by the erect hypanthium top (Very widespread and variable: Marchagee–Mount Barker–Norseman)..... **L. erubescens**
 - 4: Mature fruits (including pedicel) usually longer than broad, lacking a conspicuous rim
 5. Upper surface of fruit raised near the style base into 5 ridges
 6. Hypanthium tapering gradually to a narrow pedicel. Placenta high in the loculus, ovules 4–12, in 2 rows (Boxwood Hill–Cape Arid) **L. maxwellii**
 - 6: Hypanthium tapering rather abruptly to narrow a narrow pedicel. Placenta not high in the loculus, ovules *c.* 20, in 4 rows (Disjunct: Geraldton area–Wongan Hills; Albany area–Cape Le Grand NP) **L. oligandrum**
 - 5: Upper surface of fruit evenly rounded
 7. Hypanthium markedly expanded in the upper half (best observed in late flower or fruit); basal portion tapering gradually to a pedicel 3–7 mm long; hypanthium indumentum appressed (S of Hyden–Cape Arid NP) **L. incanum**
 - 7: Hypanthium not further expanded in the upper half; basal portion abruptly contracted to a pedicel 1.5–5 mm long; hypanthium indumentum appressed or spreading (Widespread: Wongan Hills–Fitzgerald River NP–Yellowdine, with scattered occurrences further E) **L. nitens**

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References

- Bean, A.R. (1992). The genus *Leptospermum* Forst. et Forst. F. (Myrtaceae) in northern Australia and Malesia. *Austrobaileya* 3: 643–659.
- Bean, A.R. (2004). Three new species of *Leptospermum* (Myrtaceae) from Queensland and northern New South Wales. *Telopea* 10: 831–838.
- Binks, R.M. & Byrne, M. (2022). Species delimitation, hybridization and possible apomixis in a rapid radiation of Western Australian *Leptospermum* (Myrtaceae). *Botanical Journal of the Linnean Society* 200: 378–394.
- Binks, R.M., Heslewood, M., Wilson, P.G. & Byrne, M. (2022). Phylogenomic analysis confirms polyphyly of *Leptospermum* and delineates five major clades that warrant generic recognition. *Taxon* 71: 348–359.
- Lyne, A.M. (1993). *Leptospermum namadgiensis* (Myrtaceae), a new species from the Australian Capital Territory–New South Wales border area. *Telopea* 5: 319–324.
- Lyne, A.M. & Crisp, M.D. (1996). *Leptospermum jingera* (Myrtaceae–Leptospermoideae): A new species from north-eastern Victoria. *Australian Systematic Botany* 9: 301–306.
- O’Brien, M.M., Quinn, C.J. & Wilson, P.G. (2000). Molecular systematics of the *Leptospermum* suballiance (Myrtaceae). *Australian Journal of Botany* 48: 621–628.
- Thompson, J. (1989). A revision of the genus *Leptospermum* (Myrtaceae). *Telopea* 3: 301–449.



Referees for Volume 33

The assistance of referees in providing expert review of papers submitted to *Nuytsia* is gratefully acknowledged. The referees consulted for Volume 33 include those listed below and seven anonymous reviewers. Each paper was also refereed internally by *Nuytsia* Editorial Committee members.

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The cover photo for Volume 33, which features the iconic Larrgari Tree (Boab; *Adansonia gregorii* F.Muell.), was captured by Adrienne Markey from atop Mt Joseph in the central Kimberley and looks north-east across Bunuba country, with the Miliwundi Ranges in the background.

